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A Training Decision Support System for Tennis Coaches

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A Training Decision Support System for Tennis Coaches

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1. INTRODUCTION	5
2. METHODOLOGY	6
PART 1	8
3. RELATED LITERATURE	8
3.1. IMPORTANCE OF DECISION-MAKING PROCESS	8
3.2. THE PLACE OF DECISION-MAKING IN SPORT	13
3.2.1. DEFINITION AND DESCRIPTION OF DECISION-MAKING IN SPORT	13
3.2.2. COACHES' SKILLS REQUIRED FOR AN EFFECTIVE DECISION-MAKING PROCESS	16
3.2.3. COACHES' DECISION-MAKING STYLES	19
3.2.4. TECHNICAL AND TACTICAL ASPECTS OF DECISION-MAKING IN SPORT	20
3.3. DEFINITION AND ANALYSIS OF DECISION SUPPORT SYSTEMS (DSS)	24
3.3.1. DEFINITION, GOALS AND EVOLUTION	24
3.3.2. ANALYSIS OF DSS STRUCTURE	26
3.3.3. TYPES OF DECISION SUPPORT SYSTEMS	30
3.3.4. COMPARISON BETWEEN DSSs AND OTHER MANAGEMENT SUPPORT SYSTEMS (MSSs)	32
3.3.5. BUSINESSES IMPACTED BY DECISION SUPPORT SYSTEMS	33
3.4. APPLICATION OF DECISION SUPPORT SYSTEMS IN SPORT	34
3.5. CONCLUSION	35
PART 2	37
4. A DECISION SUPPORT SYSTEM FOR TENNIS COACHES	37
4.1. ANALYSIS OF THE WORKING ENVIRONMENT OF TENNIS COACHES	37
4.1.1. INTERVIEWS	37
4.1.2. ANALYSIS OF PROBLEMS AND NEEDS OF TENNIS COACHES	40
4.1.3. DECISION-MAKING PROCESS OF A TENNIS COACH	43
4.2. DESCRIPTION OF THE SYSTEM STRUCTURE	44
4.3. TECHNICAL DESCRIPTION OF THE SYSTEM ELEMENTS	48
4.3.1. USER INTERFACE AGENT	48
4.3.2. PLAYERS AND COACHES DATABASE	49
4.3.3. ESTIMATION LEVEL AGENT	51

4.3.4. GROUP CREATION AGENT	54
4.3.5. KNOWLEDGE BASE	57
4.3.6. TENNIS TRAINING AGENT	60
4.4. POSSIBLE CONTRIBUTION OF THE SYSTEM OUTPUTS	61
<u>5. CONCLUSION</u>	<u>62</u>
5.1. FURTHER WORK	63
<u>REFERENCES</u>	<u>64</u>
<u>APPENDIX</u>	<u>71</u>

1. Introduction

The modern world is undergoing technological changes that generate development opportunities for companies and managers. Sources and types of information are more and more diversified and technological tools dedicated to information analysis are increasingly advanced (Aydin et al., 2015). Dong and Srivastava (2015) notes that number of data generated worldwide is exponentially increasing, forcing the development of new technologies to deal with an unprecedented amount of data.

The constant increase of data and information processed has a strong impact on the way decisions are made in the business (Francis, 2019). Sport seems to be an area where decision-making processes are increasingly studied in the literature. In recent years, the emergence of new technologies has inspired researchers and experts to develop and use computer systems to enhance sports performance, including facilitating decision-making processes. Cai and Shi (2013) notes the positive contribution that a computer system can have on decision-making in sport. Tennis is a sport where all the people involved must make complex decisions, especially coaches (Kaya, 2014). Tennis coaches face some recurring problems in player management. Delforge and Le Scanff (2006) studied problems related to players' parents. According to the authors, parents are the main source of problems for tennis coaches. It is assumed that there are other types of problems encountered by tennis coaches. Based on this hypothesis and the positive contribution of decision support systems in sport noted in the literature, research questions are formulated:

"What decisions does a tennis coach have to make? What are the problems and needs associated with these decisions? What would be the contribution of a decision support system based on these elements? "

In order to answer these questions and achieve the objective of this work, which is to create a decision support system for tennis coaches, a research methodology is used. This methodology, explained in detail in the following section (section 2), consists in studying the literature on the decision-making process in sport and the characteristics of decision support systems in order to provide the theoretical references necessary to create the system. A survey to identify the decisions made by a tennis coach and the problems related to these decisions is

created. A panel of coaches are interviewed, their responses are analyzed to determine the structure and objectives of the decision support system developed in this work.

This work is structured in 5 sections, including the introduction. Section 2 presents a detailed description of the methodology used. Section 3 reviews the most relevant literature related to decision making in tennis. Section 4 describes the process of developing a decision support system for tennis coaches. Finally, section 5 concludes according to the stated objectives of the system and defines future work lines.

2. Methodology

This work is based on a study methodology centered on an analysis of the literature on decision-making in sport to provide the theoretical foundations for the design of a decision support system for tennis coaches. Therefore, this work is split into 2 separate parts. The first part aims to analyze in detail the literature and the second part contains the different stages of the system development.

Several publications are analyzed in Part 1. Different concepts, identified as important, are defined and illustrated. This part is structured in 4 different sections. The literature review is increasingly specific across sections. The first section is dedicated to the study of decision-making process and its importance. An identification of the different types of process inputs and their characteristics is made. Then, an analysis of the place of decision-making in sport is carried out, focusing on the impact of coaches can have on players, their skills and styles. An analysis of the importance of tactic and technique in sport is conducted. It appears that tactics and techniques are key concepts related to sport performance. A description of these concepts is made to determine how to estimate athlete's tactical and technical skills. This makes it possible to identify the different qualities that a tennis coach must possess to carry out specific training. Afterwards, a definition and an analysis of decision support systems (DSSs) are performed. The objectives of some of the different types of decision support systems are analyzed and compared. An analysis of the characteristics of the different elements that make up these systems allows to identify the most suitable components and structure of a decision support system for tennis coaches. The characteristics of certain businesses impacted by decision support systems are studied. The last section deals with an overview of DSS

applications in sports to analyze the type of sports decisions that are impacted. It appears that many sporting features (mental, physical, technical, tactical...) are common between different sports disciplines, including tennis.

Part 2 of this work is dedicated to the development process of a decision support system for tennis coaches. A survey designed for tennis coaches is constructed in the first section to collect information about the decisions made by a tennis coach, the problems and needs related to these decisions and the possible contribution of such a system. Based on the answers collected from 3 different coaches, a decision-making process is modelled. The problems and needs related to tennis coaches' decisions are identified. The second section contains a description of the structure of decision support system developed. A functional description of each system element is provided in Section 3. Finally, the possible contributions of such a system are expressed.

PART 1

3. Related Literature

3.1. Importance of Decision-Making Process

In a constantly evolving society, the place of decision-making process is increasingly important for the optimal development of a company. In business, managers and executives need to make decisions with the best intentions for the company. The health of the business depends on appropriate decisions. A good decision should preferably have several inputs to allow multiple people grouping as a team to decide with the help of experts in the domain (Francis, 2019).

Decision-making can be described as the intellectual process of selecting based on the decision-maker's values and preferences among several options in order to obtain an appropriate final solution. Most of the time, decision-making corresponds to the study of the identification of alternatives (Kaya, 2014). However, Francis (2019) expresses the fact that it seems preferable not to describe the decision-making process as being based only on the values and preferences of the decision-makers. An objective analysis of the facts and situation must be carried out to collect a multitude of inputs. These inputs are required for decision makers to make the most appropriate decisions possible.

The inputs needed for decision-making come from different sources and are of different types. Decision makers based their decision on knowledge and information. Most of the time, information is based on a detailed analysis of a large mass of data from both laboratory and field, that show how human problem solving and decision-making take place in a wide variety of situations (Simon, 1979). This wide variety of situations makes data collection and interpretation more complex and requires more appropriate elicitation process.

To understand the input collection process, a definition of some concepts as Data, Information, Knowledge, Understanding and Wisdom and the relation between them are needed in order to identify the different types of inputs available to decision-makers.

Data

According to Russel Ackoff (1999), data are “*symbols that represent the properties of objects and events*”. Data can be expressed as a raw representation of objects and events. A further elaboration of Ackoff's definition has been made by Bellinger et al. (2019). According to them, data simply exists and has no significance beyond its existence. It can exist in any form, usable or not but don't have meaning of itself. Therefore, it's not interesting for the authors to interpret data without any further processing. These processes are made to increase the usefulness of data and transform it into information.

Information

Information is descriptive elements that answer to questions that begin with such words as who, what, when, where, and how many (Ackoff, 1999). Bellinger et al. (2019) express information as data which have meaning by the relation connection between them. There are different ways to identify the meaningful relations between data as mathematical formula, descriptive statistics...

Knowledge

Knowledge is conveyed by instructions, answers to how-to questions by application of data and information (Ackoff, 1999). Bellinger et al. (2019) complete this definition by including the fact that knowledge is represented by a deterministic process. Information are processed to be useful in an appropriate situation. Indeed, knowledge is the answer of a question but is useless if the condition of this question change. In term of computer parlance, applications are designed with modeling, simulations... based on stored knowledge. Therefore, it's not possible to resolve every problem with knowledge analysis because, most of the time, problems or questions aren't the same than those previously encountered.

Understanding

A thorough understanding of the problems that cannot be solved with knowledge is necessary. Cognitive and analytical abilities are required to solve evolutive problems. The main difference between knowledge and understanding is that understand a problem allows to answer to why questions by explanations (Ackoff, 1999). Understanding process is a probabilistic process where learning is associated to memorize. People who understand can use knowledge of previous experiences and synthesize new knowledge to undertake useful actions in new situations (Bellinger et al., 2019). An artificial intelligence (AI) systems is considered by Bellinger et al. (2019) as a process which can understand problems by its capacity to stock

knowledge and synthesize new knowledge from it. Intelligence granted by understanding is the ability to increase efficiency of every decision made but it this does not increase the effectiveness of a decision. Values are needed to exercise a judgment and make an effective decision.

Wisdom

Wisdom deals with effectiveness related to a decision. Efficiency is an impersonal principle. It's possible to estimate the efficiency of an act without knowing the person who took it. Therefore wisdom, which is defined as a value judgement of an act, is not needed to increase efficiency but is needed to increase effectiveness (Ackoff, 1999). Wisdom is an extrapolative process which give understanding about things not previously understood. The concept of wisdom allows to ask questions that may never be answered with a philosophical approach. Concretely, wisdom is a process by which people can discern between good and bad in every decision. Unlike the other four concepts, wisdom cannot be modeled for computers. It based on somethings difficult to quantify as feelings, ability to decide with compassion, ... (Bellinger et al., 2019).

It exists a clear transition between data, information and wisdom. These four concepts each represent a step in the decision-making process. The following diagram (cf. Figure 1) shows two ways (a pyramid and or a chain) of representing the relationship between data, information, wisdom and knowledge.

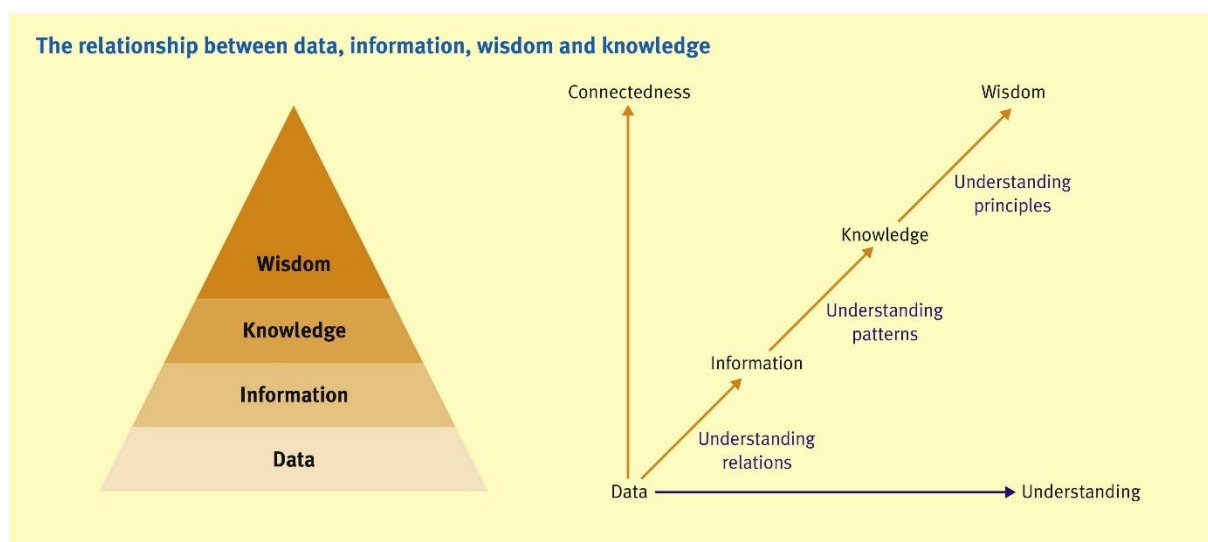


Figure 1 : The relationship between data, information, wisdom and knowledge (Cooper, 2010)

The concept of understanding allows to step up in the chain or in the pyramid from data to wisdom. Cooper (2010) gave some examples in relation with the medical field to illustrate how data become wisdom. Data are value without meaning by itself as a heart rate of 50. By understanding relations between data in a context, data are transformed into information. Therefore, information can be interpreted thanks to the context as a heart rate of 50 for a young sporty adult or an old person. Understanding patterns created by previous information and knowledge collected over time allows to make a better decision in a known context. Knowledge in a situation allows people to know how to deal with a problem. Knowledge makes it possible to anticipate with great probability the sequence of events. In a medical environment, the knowledge management is essential in order to provide the most appropriate medical care to patients based on the information collected (Cooper, 2010). Similar thinking applies to the world of sport, the sharing of knowledge from different sources can be useful for an athlete who wants to progress. Understanding principles is essential to the wisdom process. This process applies knowledge in an ethical or moral framework allowing the distinction between good and evil (Cooper, 2010).

How to make a decision is sometimes more important than the decision itself. According the Latham (2015), the best way to make appropriate decisions involves a four-step process called SOAR (Strengths, Opportunities, Aspirations, Results).



Figure 2 : The SOAR Process¹

¹http://www.globallearningpartners.com/images/uploads/case_studies/soar_process_2.jp

“A Strengths, Opportunities, Aspirations, Results (SOAR) analysis is a strategic planning tool that focuses an organization on its current strengths and vision of the future for developing its strategic goals (Stavros and Hinrichs, 2019)”. Based on this analysis, decision maker can make the most appropriate decision depending the situation. The approach of the SOAR analysis (cf. Figure 2) consists to use the greatest strengths of an organization to identify the best opportunities. Opportunities are defined by Stavros and Hinrichs (2019) as external circumstances that could improve profits or unmet customer needs on the market. Strengths and opportunities give indications about aspirations of an organization to decision-makers. Aspirations allows an organization to define how it wants to be perceived in the market. Estimating progress made by an organization by measuring results obtained based on aspirations is the last step of the process. Results are expressed by tangible, measurable items.

The SOAR process is different from the SWOT (Strengths, Weaknesses, Opportunities, Threats) process because unlike the SWOT analysis, the SOAR analysis focuses on what works well in all functional areas of an organization. As a result, SOAR process does not consider weaknesses and threats (Stavros and Hinrichs, 2019). An analysis with a positive philosophical approach as the SOAR analysis has several benefits as the reduction of resistance to change by including representatives of every level of an organization in strategic planning. The process is flexible in case of decision modifications made by an organization. The thin book of SOAR expresses the decision-making based on strengths more effective than using weaknesses (Stavros and Hinrichs, 2019). However, it seems very unrealistic to think that a without questioning approach will be effective for each decision. According to the SOAR process, weaknesses and threats of the organization are expressed as possibilities. Sometimes, it seems interesting to identify the weaknesses and threats specific to an organization independently to have the opportunity to improve performance.

According to Latham (2015), the decision-making is a top priority for decision-makers to create a culture of clarity with all the stakeholders of a business process. Following each steps of the SOAR decision-making process and including the right people in it are essential to make an optimal decision. Latham (2015) identified some reasons why how you make decision is more important than what you decide. Deciding using a clear and structured process saves time and helps to make better decisions. By clearly defining the role of each stakeholder in the process, this increases everyone's efficiency and dedication. The author wants to highlight the fact that when a decision is made in agreement with all the stakeholders in a clear process, the

decision is better endorsed, and stakeholders are more willing to implement it. Clarity about how decisions should be made is essential (Latham, 2015).

It seems that there are several processes built to identify and improve each step of the decision-making process in a global way. In order to develop a decision support system for tennis coaches, it seems interesting to study decision-making in sports.

3.2. The Place of Decision-Making in Sport

3.2.1. Definition and Description of Decision-Making in Sport

Decision-making is a fundamental element in sport, especially in some sports or at a certain level of professionalism. It appears that a multitude of decisions of different types must be made by different agents in order to win a competition or improve in a sport discipline. Decisions are different when it comes to team or individual sports and are crucial when it comes to very dynamic sports such as football, basketball, rugby... (Kaya, 2014). Indeed, the coordination between players and the decision-making speed of each team member are characteristics that are very often linked to team performance. Decision-making seems to be the essence of most individual sports with a very important technical and tactical aspect such as tennis, table tennis, motor sports (F1, Rally...). The individual nature of these sports makes the decision-making of an athlete determinant when the competition gets intense. The example of a F1 driver who must decide whether to overtake a competitor at the end of a straight line at more than 300 km/h expresses the importance of the pilot's ability to make the right decision at the right time. Some decisions are less dangerous but just as decisive for the result of a competition as the decision made by a tennis player regarding the targeted area while serving or to play a drop shot at an unexpected moment....

It appears that a multitude of decisions are not taken by athletes directly. Indeed, there is a set of decision agents according to Johnson (2006) such as coaches, spectators, medical staff, referees... The author brings together all the tasks performed by athletes (play-calling, ball allocation...) as well as the sporting context (during play, weather, ...) in order to analyze the characteristics of decision-making in sport. However, Johnson (2006) clearly explains that all elements involved in a decision-making process form a unique combination that makes each

decision different. While nuancing, the author identifies three general characteristics in all decisions made in the field of sport:

a) Decisions in sport are naturalistic

The naturalistic aspect of decisions in sport is identified by Johnson (2006) based on the description of naturalistic decision-making by Orasanu and Connolly (1993). They explain that all decisions are made daily in a natural environment. The natural environment of an athlete represents the practice of sport. The analysis of decision making depends on whether the decision is made in a natural environment or in a controlled environment. Klein and Klinger (1991) tried to understand how humans make decisions in complex real-world settings in order to identify features of naturalistic decision-making. The authors gathered ten features of naturalistic decision making (cf. Appendix A). A decision is considered as naturalistic if there are defined goals and structured tasks for decision-makers. Naturalistic decision is made in a context of uncertainty, ambiguity and missing data in continually changing conditions. One of the main features of a naturalistic decision is the real-time reactions of decision makers to a change of conditions while considering the stress and all the stakeholders who influence the decision.

It appears that a distinction is clearly expressed in recent research between decision-making in the real world and decision-making in a laboratory. Johnson (2006) explains the naturalistic aspect of decisions in sport with the example of a footballer who must decide who to pass the ball to. The author compares the scenario where the player decides to pass the ball to a teammate in a real football match and the scenario where a computer program selects the teammate who will receive the pass. It appears that replicate a natural environment increases the risk of programming the players' reaction in the wrong way. The best way to study how the player made his decision is to analyze it in his natural environment, during a real football match.

b) Decisions in sport are dynamic

According to Johnson (2006), most sport decisions are dynamics and made over time. There are internal and external dynamics that influence differently an athlete's decision. Internal dynamics express the fact that an athlete is not able to gather and process all information instantly. A decision-maker does not make his decision immediately, he gathers more information over time. As a result, processing this additional information takes extra times and

influences the final decision. External dynamics express the fact that a situation in sport can change very quickly over time. Indeed, Johnson (2006) uses football again to contextualize these situations changes faced by athletes. Sometime, information about the goalkeeper's position is available for a player but the next second, he may have the view hidden by another player. Therefore, he must adapt his decision, such as hitting to the left or right of the goalkeeper, in a short period of time. To conclude, it appears that the dynamism that characterize the practice of a sport leads to inevitable changes in decisions made by an athlete over time.

c) Decisions in sport are often made “online”

Johnson (2006) highlights the fact that decision-making in sport is often performed “online”. By "online", he wants to express the fact that most decisions are made under high time pressure during the activity (i.e. during a match). Johnson (2006) points out that this characteristic is strongly related to the dynamic characteristic of decision-making in sport. However, he explains the nuance between these two characteristics by specifying that a sport is a dynamic task that can be performed both "online" and reflectively. The "online" way could be expressed by all the decisions made during a match by a player. The reflective manner could be expressed by all the decisions made by a coach before the match (choice of players on the field, tactical disposition of the team...). By explaining this, the author wants to highlight that most decisions are made while the game is in motion.

The unpredictability of sport seems to be the basis of competition. Fans' passion for a sport depends on the unpredictability of the result. Indeed, it seems obvious that a too predictable sport in terms of results would be less interesting. Johnson (2006) points out that a certain number of variables must be considered when making decisions in sport. It appears that most athletes and coaches try to anticipate as many situations as possible. Implementing a possible response to each situation that an athlete might encounter during a competition can often be useful. However, it seems important for the author to leave room for unpredictability in order to develop the player's ability to adapt but also to surprise the opponent. A tennis player who can hide the chosen playing area on serve makes himself unpredictable to his opponent and therefore more efficient. The concept of unpredictability in sport makes the construction of systems studying sports decisions and behaviors quite complex. The use of cognitive models seems to be a good approach for Johnson (2006) to understand complex decisions in sport.

According to Kaya (2014), it is complicated to identify identical and systematic decision-making processes for each sport and between different sports. However, the author attempts to identify the common characteristics of different decisions made by grouping them together using the methods used by coaches and athletes. Each decision-making in sport is made up of a set of elements that influence the way in which that decision is made. These elements allow researchers and particularly Kaya (2014) to study strategies and designs of decision-making in sport by looking to contributing factors as styles and technical and tactical strategies of coaches and athletes.

Before analyzing the place of technical and tactical skills for an athlete in an effective decision-making process, it's seems important to define coaches' role in this process.

3.2.2. Coaches' skills required for an Effective Decision-making Process

Coaches make a multitude of decisions that are critical to a team or athlete. Each coach has a coaching style and can be associated with a decision-making style. Over time, some of the research in the field of sports coaching has focused on improving coaching techniques. Kaya (2014) studies the contributing factors for coaches and how they apply their experience and methods to improve athlete's decision-making and performance. The author attempts to define the decision-making process of coaches by using results of several researchers in the field. He attempts to group together characteristics that a coach must possess to provide effective coaching.

There are several definitions related to the characteristics that coaches must have to make effective decisions. Potrac et al. (2000) recommend the use of systematic observation instruments to identify the behaviors that coaches should adopt. These instruments collect a set of observable data on coach's behavior. The ability to collect and analyze measurable data on a set of parameters that influence an athlete's performance are skills that a coach should possess. However, these instruments showed inconsistencies in term of results in the literature. Based on this observation and Dick's (1989) analysis, Potrac et al. (2000) point out that an effective coaching process remains an art that depends on the social context and the coach's ability to adapt to unique situations without dependence on predefined decision-making patterns. A

successful coach is a coach who can gather knowledge about an athlete or a team in order to accurately identify the most appropriate and effective pedagogical behavior to adopt.

Sherman et al (2000) conducted a study to identify the coaching behavior preferences of several Australian athletes of different sexes in different disciplines. Based on the results, they focus on the specialization skills a coach should have. According to them, a coach must be able to provide specialized technical, tactical, physical and psychological preparation for a team or an athlete while possessing leadership skills. It would appear at first glance that these qualities are often linked to the coach's experience in the field. Indeed, a coach who has been a top athlete in his discipline has experience. According to Gilbert and Trudel (2005), being a former high-performance athlete with a long experience is not a guarantee of effectiveness as a coach. In their research, the authors tried to collect information to determine how coaches learn to coach. They tried to determine the conditions and sources of inspiration for coaches. Gilbert and Trudel (2005) point out that the first source of knowledge for coaches is the experience of other coaches. However, the definition of an effective coach differs according to the sport and the level of professionalism. A coach working with youth amateur teams can be considered effective if he can motivate his players by creating a group dynamic. A coach with experience officiating in a professional team will be considered effective if he achieves positive results in competitions. A coach with experience can be considered as an expert but his experience does not guarantee his effectiveness.

In order to understand coaches' decision-making process, Gilbert and Trudel (2001) examined the process of learning of youth team sport coaches based on experience and reflection. This analysis helps to understand the steps coaches must face and the decisions they must make. The authors identified six components of the reflection process:

- 1) **Coaching issues:** Inputs that trigger the coach reflection. The results of the study show that coaches only engage a reflection process to develop a new strategy if they encounter problems with their athlete(s). Coaching problems are grouped into 5 categories for youth teams: athlete behavior, athlete performance, coach profile, parental influence and team organization.
- 2) **Roles frames:** The reflection is conducted by the coaches' personal approach of coaching. This framework helps to explain why some situations are problematic for coaches as well as the strategies they choose to implement.

- 3) **Issue setting:** The process of identifying an issue and deciding why it was an issue. The identification of problems is mostly done by coaches themselves. However, some problems can be identified in collaboration with other coaches (assistants, observers...) during discussions before and after the competitions. More occasionally, problems are identified in collaboration with athlete's parents and management team.
- 4) **Strategy generation:** Once an issue is set, coaches must generate a strategy. According to Gilbert and Trudel (2001), coaches have three independent sources from their peers to define their strategy, they can be inspired by coaching materials such as books, videos... dealing with their problems. They can create a strategy from their creative thoughts based on their own knowledge. This method seems to be the most widely used according to the study carried out by the authors. They can also use his repertoire of personal strategies, i.e. all the strategies they have already implemented in the past. Coaches also have three peer-reliant options to define his strategy. They can seek advice from a colleague. They can also build a strategy in collaboration with peers. The transformation of a strategy implemented by another coach after observation is also an option for strategy generation. Depending of the problem, it appears that a combination of all these sources is the most used solution by coaches.
- 5) **Experimentation:** Once the strategies have been defined, there are two ways to test it, virtually or in reality way. Coaches can virtually test their strategies on paper or electronically before the implementation on the field during a match or a training session
- 6) **Evaluation:** A review of coaching strategy effectiveness by himself, peers or others is made. Comments from outside (parents, observers...), peers (assistants, colleagues...) or personal introspection allow coaches to evaluate the effectiveness of the decision made regarding the strategy.

A representation of the process including a detailed description is available in the paper of Gilbert and Trudel (2001). This process shows that it seems possible to set up a predefined

reflection scheme to help coaches make their decisions. However, adaptability, flexibility and openness to others seem to be essential characteristics for coaches to make effective decisions.

3.2.3. Coaches' Decision-Making Styles

The study of the decision-making process of sport coaches in the literature led to the identification of different behaviors adopted by coaches with their athletes. A coach's style can be described as the way he makes decisions and makes these decisions applied by his players. Chelladurai and Arnott (1985) identifies three styles of decision-making:

- The autocratic style
- The participative style
- The delegative style

According to their conclusions regarding the most effective style to adopt for a coach, it appears that a coach must adapt his coaching style to the problems and situation encountered. Coach's personality is not a factor to determine the decision-making style.

Several authors agree with Chelladurai and Arnott's (1985) conclusion about the flexibility that a coach must show. Sherman et al (2000) concluded their study on athletes from three different sports that the coach's ability to adapt his style to the athletes' personalities is essential. Indeed, the study showed that coaches who advocate positive feedback and clear instructions expressed in a democratic way are widely preferred by athletes. This decision-making style based on the athlete and the situation is called the cooperative style by Elderton (2006). Knowing what your coaching style is and being able to change it is critical in order to appeal to the different types of athletes that you coach (Gilbert and Trudel, 2005).

The notion of feedback is essential to the improvement of athletes and coach decision-making (Voight, 2002). According to him, it is essential for a coach to receive and give feedbacks to athletes so that they can improve. A coach should not hesitate to stop training in order to give feedbacks or demonstrate an explanation (Hodges and Franks, 2002).

Another notion that must be considered by a coach in order to improve and adapt his decision-making style is his verbal behavior (Lacy and Darst, 1985). The way of speaking, the

choice of words and the efficient use of speaking time have a strong influence on an athlete's or team's performance. Indeed, it appears that a coach who screams too loudly in inappropriate language and at too high frequency is ineffective in making his team understand his choices.

3.2.4. Technical and Tactical Aspects of Decision-Making in Sport

Athlete's technical and tactical skills are important elements in a coach's decision-making process (Kaya, 2014). An athlete's level in a sport is often correlated with his technical and tactical skills (Hawkins et al., 2015).

Technical skills refer to specific body movement procedures to perform an action (Martens, 2012). Dribbling, shooting and passing a ball optimally are part of a basketball player's technical skills (Hawkins et al., 2015). Some technical skills are considered as generic and can be applied to several sports (running, jumping...) while others are considered as specific to a sport (tennis service, golf swing...) (Ocr.org.uk, 2019). Santos (2009) grouped technical skills into three categories by analyzing how an athlete's movement begins and ends. The categories are continuous skills, discrete skills and serial skills. Continuous skills grouped movements that do not have an obvious start and end. These are continuous movements. Sports such as swimming or running fall into this category with all repetitive movements. Discrete skills are unique movements that have an obvious beginning and end. Serials skills are well-defined combinations of continuous and/or discrete skills constituting a movement. The author illustrates this kind of skill with a football dribbling phase where the athlete runs (continuous skill) and makes a unique movement with his feet to dribble an opponent (discrete skill).

The process of learning technical skills for an athlete is expressed in three stages (Hawkins et al., 2015):

- 1) **Mental Stage:** Cognitive understanding of what to do. During this stage an athlete must think about all his movements (example: learn to shoot basketball). Wood (2014) points out that at this stage, the athlete does not realize his mistakes, a coach must give clear and basic instructions.
- 2) **Practice stage:** An athlete spends less mental energy on what to do because fundamentals are well assimilated. During this stage, an athlete seeks to improve timing and coordination (Hawkins et al., 2015) (Wood, 2014).

- 3) Automatic stage:** An athlete has totally or almost assimilated the technique and can focus on more critical elements of the game (tactical, physical...). Performance becomes more relevant at this stage for the athlete and the coach.

Technical skills are the foundations of sports and athletic trainings, but without the tactical ability to apply these skills, they become useless and mundane. Tactical skills of an athlete allow him to put his technical skills into action (Hawkins et al., 2015). Tactical skills are defined as "*the decisions and actions of players in the contest to gain an advantage over the opposing team or players*" (Martens, 2012). Hawkins et al (2015) illustrate tactics in sport with different player placement in a basketball field such as defensive positioning, the choice of player markings or offensive patterns. Tactics deal with decisions about how to move, when to move and where to move in a dynamic environment with time pressure (Gréhaigne et al., 1999).

Santos (2019) divides sport tactics into five different aspects:

- 1) Positioning:** The position of the player or the team has a significant impact on the result. Communication between players and coach is essential to make position changes on the pitch. Santos (2019) illustrates tactical positioning with a 4-4-2 layout of football players who can evolve in 4-5-1 following the entry on the field of an opposing player.
- 2) Strokes related choices:** An athlete decides how he will hit, shoot, pass the ball. This decision is often made in high time pressure and depends on the opponent position. A tennis player must decide how to hit the ball (slice, lift ...) and the place where he will send the ball (short, long ball ...) depends on the position of the opponent. This choice also depends on the recommendations given by the coach before the match. In tennis, using the slice gives a cut effect to the ball and causes a very low rebound. This tactic is often recommended against tall players.
- 3) Variations:** In sports, tactical variations are essential to surprise the opponent. When a movement or a position is too obvious, it won't destabilize the opponent. It is important for an athlete to change something in order to create

a surprise. Santos (2019) illustrates this with a volleyball player making a fake smash at the net.

- 4) **Conditions:** The tactic depends on "internal" or "external" conditions. "Internal" conditions are the personal conditions in which an athlete play. If an athlete come back in play from injury or is less motivated, tactical disposition should be different. External conditions like the quality of a football pitch can change the tactics of a team.
- 5) **Use of space:** The available play space determines tactics to apply. A coach often recommends that the athlete play in a space where the opponent is uncomfortable.

Tactical skills are different from one sport to another and the level of the athlete does not affect the importance of tactics. Tactic depend on a multitude of things like the opponent, the style of play, the players at the coach's disposal, the playing surface.... (Ocr.org.uk, 2019). The role of a coach is crucial in setting up the tactical disposition during a match. Improving tactical skills of an athlete is one of the fundamental roles of coaches. According to Hawkins (2015), there are three tactical components that a coach must teach to his athlete. These are grouped in what he calls the "tactical triangle" (Figure 3).



Figure 3: The Tactical Triangle (Hawkins, 2015)²

² <https://slideplayer.com/slide/5712633/>

- **Reading the Situation:** Understanding and analyzing the environment are abilities that an athlete must possess in order to develop his tactical skills. An athlete must be able to gather information, process information and focus on what is important to identify the problem.
- **Tactical Knowledge:** An athlete must know the rules of the game, the game plan established by the coach, the strengths and weaknesses of the opponent. Based on this, he must be able to determine the tactical options available to him.
- **Decision-Making Skills:** An athlete must be able to make the best decision using different strategies such as the use of questioning techniques. This provides useful feedback in the decision-making process.

A player's technical and tactical level determines the approach to be taken by a coach during training. A coach must be able to understand the technical and tactical skills specific to the sport he is teaching. He must also be able to assess the technical and tactical skills of a professional athlete in his discipline in order to identify the details that can make a difference. Finally, a coach must be able to assess his own technical and tactical skills to adapt his training plan. The use of technological tools is recommended in order to more effectively transmit technical and tactical guidelines to players (Ocr.org.uk, 2019).

There are some models designed to help coach. The following section is dedicated to the study of some systems and models created to improve the quality of decision-making. It seems interesting to analyze how the literature defines decision support systems and their place in the business.

3.3. Definition and Analysis of Decision Support Systems (DSS)

3.3.1. Definition, Goals and Evolution

A Decision Support System (DSS) refers to a computer-aided system that helps managers and planners to make decisions in different domains. DSS combines the power of human thought with the power of modeling systems to get optimal, informed decision making. In a world where technology knows an exponential evolution and the power of decision increase economically, systems as DSSs are considered by many businesses as a way to respond to current economic challenges. The appearance of different types of data from different type of sources encourage managers to use the power of modeling systems to make better decision in time (Stoltzfus, 2017).

According to Shim et al. (2002), a decision support tool is built with different components capable of performing 3 roles:

- 1) To manage sophisticated database with access to internal and external data, information and knowledge from a variety of sources.
- 2) To use powerful modeling functions accessed by a model management system.
- 3) To design a powerful and simple interface capable of handling interactive queries associated with reporting and graphical functions.

Over time, the definition and composition of decision support systems have evolved with technological development. However, it appears that Gorry and Scott Morton (1971) are considered as references for the original definition of the DSS concept. Based on the literature, the authors grouped decisions into three categories of problems: structured, unstructured and semi-structured. It is possible to develop a computer system to solve structured problems, but the judgment of the decision maker remains essential in the resolution of semi-structured or unstructured problems. As a result, Gorry and Scoot Morton (1971) describes decision support systems as computer systems that at some point deal with a semi-structured or unstructured problem.

According to Nelson Ford (1985), a decision support system has four characteristics:

- 1) It is often used by top level managers because they deal with unstructured problems more than lower level managers.
- 2) It allows decision makers to use complex and time-consuming quantitative analysis techniques with relative ease.
- 3) It is designed to be user-friendly to be used by decision makers who are not used to computers.
- 4) It emphasizes flexibility to facilitate decision changes.

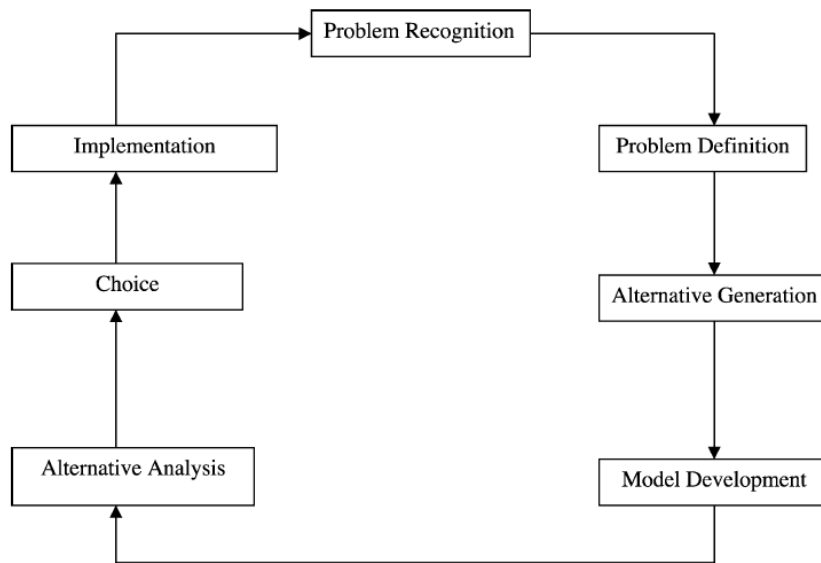


Figure 4 : Basic decision-making process in a DSS environment (Shim et al., 2002)

Figure 4 is used by Shim et al (2002) to represent the basic decision process used to construct a decision support model. The objective is to build a model based on the identification of problems. Problems are defined to facilitate the construction of a model. A set of alternative solutions to problems should be issued. The model is developed in such a way to analyze the different alternative solutions. The model recommends one or more solutions and the decision-maker makes his choice and implements it. According to the authors, this process can only be followed when a structured problem is identified, which is rarely the case.

Over time, research on DSSs has evolved with the emergence of new concepts that make it easier to make decisions. The emergence of techniques from artificial intelligence (AI) and expert systems (ES) has improved decision support models and therefore facilitated

decision making (Bidgoli, 1998). Bidgoli (1998) believes that the use of techniques such as neural networking, genetic algorithms and fuzzy logic, which are techniques considered by the literature and the author as "intelligent", will improve decision-making.

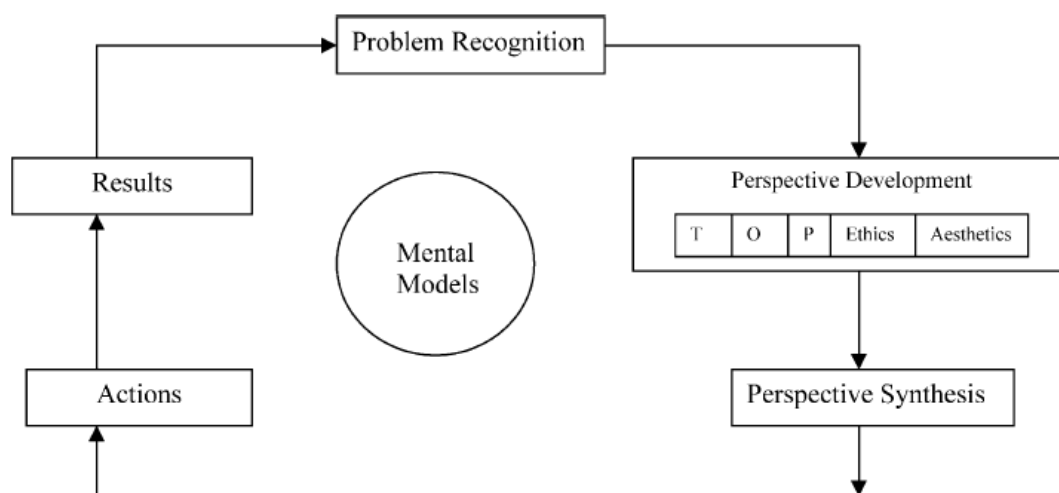


Figure 5: A new decision paradigm for DSS (Courtney, 2001)

The emergence of new techniques to support decision-making and the diversification of domains using DSSs encouraged Courtney (2001) to modify the basic decision-making process shown in Figure 4 to create a new model (c.f. Figure 5). The author incorporates various perspectives during the problem formulation phase. Perspectives are developed from organizational (O), personal (P) and technical (T) positions considering ethical and aesthetic factors. The mental models of the participants make it possible to analyze what the problem is and to analyze the result of the solutions proposed by the system.

In order to have a more in-depth understanding of decision support systems, an analysis of some of the components of DSSs is carried out below.

3.3.2. Analysis of DSS Structure

Technologies and components of a decision support system describe its structure (Nelson Ford, 1985). It appears that the components of a decision support system vary according to the objective of the system. The choice of tools to build the system is based on several factors around the decision-maker's environment (problems, needs, budget...).

However, some authors group the different components into categories to define a structure considered as standard.

Kukreja (2019) defines the structure of a decision support system with three main components represented in Figure 6.

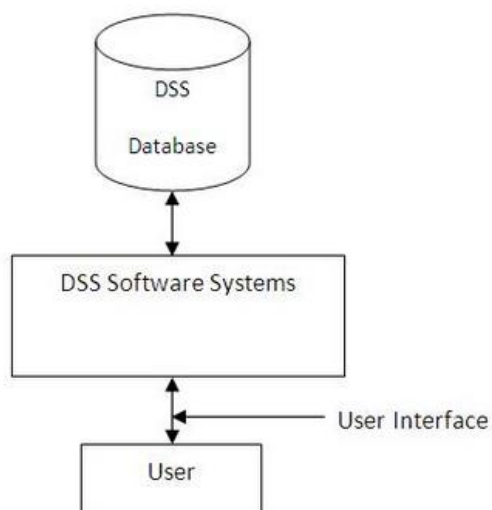


Figure 6: Components of decision support systems (Kukreja, 2019)

- **DSS Database:** A database containing data of different types and from various sources (internal and external). All the data required by the system's models and tools for a recommendation on the decision to be taken are contained in this database. Its size varies and can be small or very large. In the case of a system that supports the needs of an organization, the database can be transformed into a data warehouse (Kukreja, 2019). Inmon (1996) defines a data-warehouse as "*a subject-oriented, integrated, time-variant, nonvolatile collection of data*". The use of data-warehouses makes it possible to integrate and query data from a multitude of operational databases. As a result, data-warehouses can increase the range of data to support decision-making more effectively (Kimball and Ross, 2002).
- **DSS Software System:** It is composed of various mathematical and analytical models to analyze inputs as complex data and provide an output to support decision making.

Models to be incorporated into a DSS depends on the purpose of the system and the decision-maker's needs. Kukreja (2019) groups these models into 5 categories:

- 1) **Statistical Models:** Models including all descriptive statistics tools as well as functions to infer possible data values.
- 2) **Sensitivity Analysis Models:** Models based on the "what-if" concept to estimate the impact of a change in one variable on the others. This type of model makes it possible to analyze the correlation between variables and the impact of a variation on the entire system.
- 3) **Optimization Analysis Models:** Models based on an optimization objective. This type of model makes it possible to obtain the maximum value of a variable under certain constraints (time, money, etc.) and under certain circumstances.
- 4) **Forecasting Models:** Models based on prediction tools and techniques such as regression models, times series analysis... Models widely used in sales.
- 5) **Backward Analysis Sensitivity Models:** Models based on achieving an objective. These models use a set of techniques to define an objective to be achieved for a variable by modifying the value of the other variables until the objective is reached. Models often used in production to achieve a goal.

There are a multitude of other models including various and varied technologies. Shim (2002) highlights the emergence and evolution of online analytical processing (OLAP) and data mining tools. The author describes the purpose of these tools as the fast and efficient analysis of historical data stored in databases or data warehouses dedicated to data driven DSS. OLAP is a technology that allows the user to extract and compare data stored in data-warehouses or in multidimensional databases. Unlike two-dimensional databases, multidimensional databases separate each attribute of a data so that it can be analyzed with the attributes of the other data (L, 2018). Data-warehouses used by decision support systems must be multidimensional in order to allow data from heterogeneous sources to be analyzed. OLAP technology is more suitable for multidimensional database analysis and therefore for decision support systems (Chaudhuri and Dayal, 1997).

Data mining is a set of data analysis tools based on artificial intelligence to identify patterns in data in order to define its rules (Shim, 2002). For Hand (2013), data mining is not just a simple data mining tool, it allows to analyze data considered as secondary from very large storage tools.

- 1) **DSS User Interface:** The interface is interactive and allows the user to switch to the system more easily. The interface provides outputs in various formats (text, graphics, tables...) at the user's choice. Technologies from the web environment allow to create Web-based interfaces which are more accessible for users (Kukreja, 2019).

Bal et al. (2014) proposes a different model from Kukreja (2019) to represent the main structure of a decision support system (c.f. Figure 7).

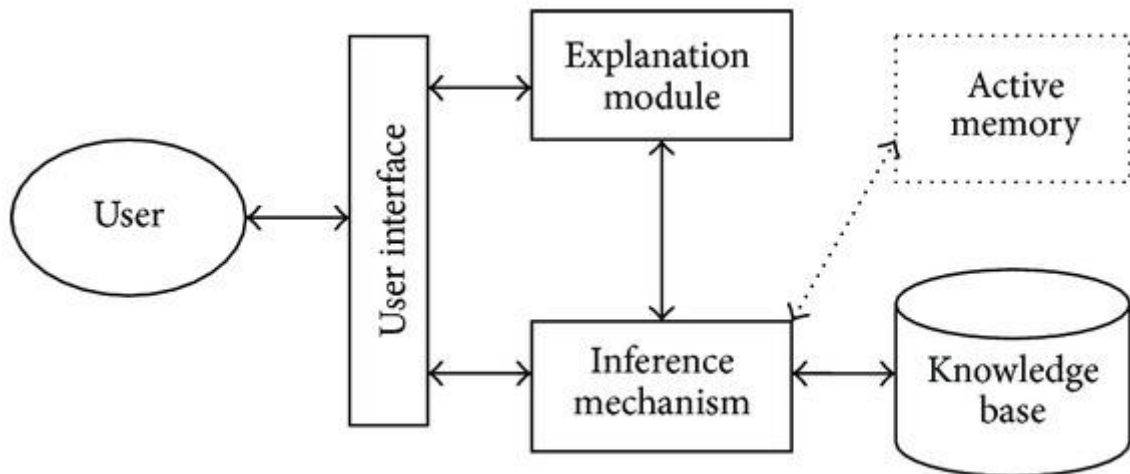


Figure 7: The main structure of decision support system (Bal et al., 2014)

The two models have similarities such as roles of the user and the user interface. Bal et al. (2014) describe the inference mechanism as the element that generates the result based on the information provided by the user and the knowledge base. This section contains a set of models that can be found in the categories defined by Kukreja (2019). The result is expressed in the form of an information guiding the decision. The knowledge base contains all the information and knowledge provided by experts in the field in which the DSS is used. It appears that the main difference between databases and knowledge bases is the level of expertise of sources. Knowledge bases are built by experts. The active memory keeps the information

provided by the user and the inferences mechanisms. The explanation module provides validation and explanation to users about the results obtained by the inference mechanisms.

It appears that DSSs composition are rarely identical because each system is created with a different objective. However, there is in the literature a grouping of DSSs by "types" based on the tools that compose them.

3.3.3. Types of Decision Support Systems

Kukreja (n.d.) identified two types of decision support systems, the models based DSSs and the data based DSSs. DSS-based models are categorized by the author as all autonomous systems (i.e. not connected with other information systems) whose analytical capacity is based on strong models. Data based DSSs are defined as the set of systems capable of analyzing a lot of data from different sources and storing it in a data-warehouse. These systems are interconnected with other information systems and allow better decision-making using techniques such as online analytical processing (OLAP) and data mining.

Power (2002) redefines a new framework grouping DSS into 5 categories according to components and tools that provide the main functionalities to the systems. The framework provides precision to the Kukreja (n.d.) model with three new categories (Knowledge-Driven DSSs, Document-Driven DSSs and Communications-Driven and Group DSSs). The framework also seems more appropriate for current hybrid systems than the one proposed by Alter (1980).

- 2) **Data-driven DSSs:** Category that includes all DSSs that query a large amount of data in storage tools (data-warehouse, database...). A data driven DSS allows the user to make queries on data that is quite simple (aggregation, average...) or with a high level of functionality (OLAP). They are intended for managers, staff or product suppliers. Examples: Business intelligence (BI) systems, reporting systems...
- 3) **Model-Driven DSSs:** Category that includes all DSSs that provide access to the use of models analyzing data and parameters provided by the user to help him to make a decision. This type of DSS does not query huge amounts of data and has simple statistical analysis tools or more complex data analysis systems (OLAP systems). Used by managers, staff members of a business or people who interact with the organization. Examples: Systems with accounting or financial models, optimization models...

- 4) **Knowledge-Driven DSSs:** Category that includes all DSSs that suggest actions to managers based on business rules or knowledge base. This type of DSS is based on business experts' knowledge base. Examples: Systems including data-mining tools or intelligent decision support methods.
- 5) **Document-Driven DSSs:** Category which includes all DSSs which integrate a set of document storage and sorting methods in order to manage, classify, sort... unstructured documents. This type of DSS allows users to find documents or web pages based on search terms. Example: A system that includes a tool in the form of a search engine.
- 6) **Communications-Driven and Group DSSs (GDSSs):** Category that includes all DSSs characterized as hybrid systems combining technological communications and decision support models. The objective of these systems is to support group decision-making. Examples of technologies present in this type of system are electronic conversation systems, emails, two-way interactive video...

The literature seems to be quite extensive about some types of DSSs. Arnott et al (2009) looks at the different research and studies conducted on certain types of DSSs in order to identify the types of DSSs most studied by researchers. According to the results conducted by the authors (c.f. Appendix B), the three most focused types of DSS in the literature are personal DSS, group systems and large data driven systems (EIS and data warehouses).

It appears that there are a multitude of types of DSSs based on their components. It seems interesting to compare the main characteristics of DSSs with other decision support systems in order to determine the most appropriate systems for situations. A comparison between the different management support systems and DSSs based on the literature makes it possible to justify the choice of creating an “hybrid” DSS for tennis coaches (c.f. Part 2).

3.3.4. Comparison between DSSs and other Management Support Systems (MSSs)

Management Support Systems represents a broad class of systems and models that have the purpose to support managerial actions and decision-making (Clark et al., 2007). There are several types of systems with characteristics close to decision support systems (DSSs). Clark et al (2007) highlight executive information systems (EIS), knowledge management systems (KMSs) and business intelligence (BI). However, there are other types of systems such as Management Information Systems (MISs) and Expert Systems (ESs).

Kukreja (n.d.) compares Decisions Support Systems (DSSs) with Management information systems (MISs). MISs are intended to meet information needs of a company. However, MIS does not seem to be suitable as DSSs are for more complex decision-making. According to the author, there are 4 major differences between MISs and DSSs:

- 1) MISs deal with structured problems and DSSs deal with semi or unstructured problems.
- 2) MISs are designed to provide useful information for the daily management of a business. DSSs are designed to provide specific information and decision support techniques to solve specific problems.
- 3) MISs provide predefined reports on the classic course of business processes. DSSs are interactive and respond in real time to user requests. They are more useful for estimating the effects of a change while MISs are more useful for obtaining a report on the state of a business.
- 4) MISs produces information by extracting and manipulating business data. DSS produces information by performing analytical modeling of the business data.

Bidgoli (1998) estimates, based on his research on management support systems, that decision support systems (DSS) and expert systems (ES) are the most popular and used systems. Nelson Ford (1985) makes a comparison between DSSs and Expert Systems (ESs). The author defines ES as "*a problem-solving program that achieves good performance in a specialized*

problem domain that generally requires specialized knowledge and skill". He compares the two systems in four ways:

- 1) **Objectives and intentions:** The main objective of DSSs as the support of user in his decision-making process with models and data. While ESs aim to provide a better decision than the user could have made.
- 2) **Operational differences:** DSSs allow users to make a decision in a flexible way unlike ESs which do not offer flexibility to users.
- 3) **System users:** DSSs are used by middle or upper managers who have helped to develop the system. Users of ESs are researchers or scientists who didn't help to develop the system.
- 4) **Development method:** The development approach is essentially the same between ESs and DSSs with an iterative process and the use of prototypes. The author describes the development of an ES as more time-consuming than a DSS.

3.3.5. **Businesses Impacted by Decision Support Systems**

The literature does not seem to present precise statistics about the application of DSSs in the different sectors of activity. However, a non-exhaustive review of the different businesses using DSS allows us to identify types of business that corresponds to the use of DSSs.

According to Bal et al (2014), the typical application areas of DSSs are medical sectors, management, military and all sectors of activity where decision makers are confronted with complex decision-making situations. Stoltzfus (2017) points out that DSSs are frequently used for inventory management optimization or sales optimization and projection. Kersten and Lo (2002) provide a non-exhaustive list of DSSs constructed with unique objectives by application sector. The authors underline, as Bal et al (2014), the important impact of DSSs in medicine and management in general. However, they identify other application sectors such as the environment, water resources management, agriculture, forest management, manufacturing...

It appears that the range of applications of decision support systems is very broad. As a result, it seems that there is little or no limit to the application of DSSs. As part of a work based on decision-making in sport and mainly tennis, a brief review of the literature on the place of DSSs in sport is carried out in the following section.

3.4. Application of Decision Support Systems in Sport

Sport is an area where decision-making is crucial. Consequently, there is an important place for decision-making tools for sport, especially in competition. Cai and Shi (2013) analyzed the structure and various applications of a decision support system designed for sport competition. According to them, a decision support system for sports competition is a *"computer system that forecasts the future changing trend and helps the leaderships to make a decision in the sports competition process based on the daily physical training data processing system, using intelligent computer method, and through analysis and integration of the service data"*. They promote the use of Web technologies to make dynamic and efficient decisions in real time. After their analyses, Cai and Shi (2013) conclude that a decision support system designed for sports competition has no technical constraints related to the field of application. Sport is a perfectly suited field to the creation and the use of decision support systems.

Abidin et al (2016) conducted research on the design of a DSS that can determine the best team formation and players' position in team sports. The authors recommend an in-depth discussion with the experts (coaches and managers) to determine how they place players on the pitch. With the same objective of improving the tactical aspect of a football team and surpassing the opponent's strategy, Chai and Xu (2009) proposes a new decision support model using techniques such as data mining, serial data... The objective of the system is to guide coaches and players towards a tactic that can outperform an opponent.

There are also several decision support systems developed to improve athletes' performance. Gong and Ling (2009) designed a decision support system that focuses on the psychological aspect of table tennis players. The system is a multi-agent system that aims to analyze the psychological factors that are considered when a player decides to identify his weaknesses and strengths. Wei et al (2009) developed a DSS to improve fencers' training. The model is based on a Bayesian network that studies the relationship between training process

and physiological indicators. The implementation of this system and tests performed by the authors with athletes demonstrated the system's contribution to decisions made by the coaches.

In order to obtain more specific information for the construction of a decision support system for tennis, it is interesting to analyze researches on competitive net sports. Yu et al (2010) studied and developed a decision support system with the purpose to improve techniques and tactics skills in net sports. The authors studied the impact of a decision support system composed of decision support technologies (Artificial intelligence, data mining...) and an intelligent system for acquiring data on technique and tactics in net sports. They demonstrate, by analyzing the results obtained by tennis players, table tennis players, volleyball and badminton teams at the Beijing Olympic Games which used the DSS, the significant impact of the system on performance.

After an analysis and a review of some DSSs designed for sport in the literature, it can be concluded that the usefulness of a decision support system for sport is more important when the notion of competition is considered. DSSs are also used to improve tactics in team sports but also in individual sports (net sports). The physiological aspect of the game as well as the training methods can also be improved with DSS.

3.5. Conclusion

The literature highlights the importance of the decision-making process in an expanding technological world. The quality of a decision is partly determined by the choice of inputs. There are a multitude of sources containing different inputs like data, information, knowledge and wisdom. The way to decide is as important as the decision itself, so there are processes like the SOAR process created to make the most appropriate decision possible. This kind of process creates a culture of clarity with all stakeholders in a business process.

Decision-making plays a decisive role in the majority of team and individual sports. It appears that decision-making is even more decisive when the sport is competitive. Athletes are not the only ones to intervene in the decision making, there are many speakers such as coaches, spectators, referees ... A literature review by Jonshon (2006) has helped to identify decisions in sport as a naturalist, dynamic and under pressure. The analysis of the characteristics of a coach skill required for effective decision-making shows that it is possible to identify a reflection scheme aimed at helping coaches. The unpredictable nature of sport forces coaches to be

flexible in their decision-making. Therefore, a system to help coaches must be able to handle the unexpected and adapt its recommendations accordingly. The technical and tactical skills of an athlete are critical when a coach must make decisions about the development of an athlete.

The literature brings together a diverse and varied set of decision support systems that are different because they have different objectives and users. Components and technologies used in a decision support system are designed to optimize users' decisions based on sources of information (database, knowledge base, external and internal sources, etc.). The analysis of the different types of decision support systems and their comparison with other systems such as expert systems and management information systems makes it possible to assert that DSSs are better suited to semi and unstructured problems. DSSs are more flexible systems and therefore adapted to the sport field.

Applications of DSSs to improve performances of athletes and coaches are quite broad and have few technical constraints related to the field of sport. This leaves some freedom regarding the design, structure and composition of a decision support system for tennis coaches.

Nevertheless, it is important to qualify the fact that this partial analysis of information concerning the evolution of decision support systems over time, the different types of DSSs, as the main businesses impacted using DSSs expressed in this section is not claimed as optimal. However, this analysis makes it possible to identify the concept of DSS in order to facilitate the development of a decision support system for tennis coaches (c.f. Part 2).

PART 2

4. A Decision Support System for Tennis Coaches

4.1. Analysis of the Working Environment of Tennis Coaches

4.1.1. Interviews

In order to create an initial outline of system to help coaches and tennis school managers in their daily decision-making, it seems appropriate to conduct interviews with coaches to collect information about their problems and needs.

Fontana and Frey (2005) divide interviews into three categories: unstructured, semi-structured and structured. Unstructured interviews are based on the principle that the interviewer meets the respondent without predefined questions and without a predefined theoretical framework to understand the complex behavior of the respondent without preconceived ideas (Zhang and Wildemuth, 2009). Semi-structured interviews are more flexible because composed by open-ended questions on certain topics and closed-ended questions on other topics. During the interview, the interviewer can change or add questions by adapting to answers (Luo and Wildemuth, 2009). Structured interviews are based on a list of questions defined and asked in the same order to each respondent. The purpose of this type of interview is to standardize responses in order to minimize the interviewer's influence on responses during the interview (Zhang and Wildemuth, 2009).

Based on the three categories presented by Fontana and Frey (2005), it seems appropriate to opt for a semi-structured interview for tennis coaches. Indeed, tennis is a complex sport in which coaching remains a specific concept for each coach. As we already have an idea about the structure of the system, it seems wise to opt for this type of interview in order to include open-ended questions and more specific questions. By doing so, it's possible to obtain potentially comparable answers between coaches without influencing answers too much. It is possible for the interviewer and respondents to bounce back on some questions or answers to enhance information collection.

The interview is introduced by a brief description of the project. The questionnaire is organized into seven parts containing open-ended questions in order to obtain as much relevant information as possible. The first set of questions aims to obtain information about coaches and their coaching methods. The second and third series of questions aim to obtain information on problems, needs and decisions specific to coaching in tennis. The fourth set of questions consists of questions to determine elements that are considered in the decision-making process. These questions will provide an idea of the future structure of the system and all the inputs to be considered. The 5th part of the questionnaire aims to obtain information and preferences about the user interface. Part 6 contains questions to determine the content and form of the system's recommendations. The last set of questions focuses on the contribution and interest that such a system could have for coaches. The French version of the questionnaire and the transcript of the interviews are attached (c.f. Appendix C).

Questions about the coach's personality:

- How would you describe your role in the world of tennis?
- What are the tasks you perform as a coach?
- Are you part of a tennis school? If so, what is your role?
- How many hours of training do you give on average? And how long have you been a coach?
- Do you train a specific type of player (young, adult, beginner, advanced...)? If so, how do you define a player's type?
- What is your vision of tennis (recreational, competitive...)? Do you have a specific approach about competition?
- Can you describe your involvement and your experience in competition as a coach?
- What are the main characteristics that a coach must possess in order to help his players?
- How would you define your coaching style? Do you adapt your style according to the player?
- What is the place of technique and tactic in your coaching methods?
- How would you describe your "touch" as a coach in a few words?

Questions on the problems and needs felt by coaches:

- What are the main problems encountered in your job?

Question to determine a standard decision-making process for tennis coaches:

- What do you do when a new player asks you for tennis lessons?

Questions to determine all the inputs to be considered in the design of the system:

- How do you collect the students' descriptive data?
- What is the essential information that players must provide to you?
- Based on which criteria and attributes do you base your evaluation of a player's level with a view to placing him/her in a group?
- When do you estimate a player's level? During a test day? During the first training session? Do you take information about the level of a player from outside (Former coaches...)?
- How do you collect the availability of students and coaches?
- How do you synchronize student availability with the availability of the facilities at your disposal?
- What are your criteria for forming groups?
- Do you use other criteria than age, level and schedule compatibility to form groups?
- Does a coach's personality and preferences matter when assigning groups to a coach?
- How do you determine the exercises of training sessions?
- What is the creative part of the exercises performed during training? What are your sources of inspiration to organize an optimal training session?

Questions about the shape of the user interface:

- How would you like to encode all the information about the players? On which type of support (tablet, smartphone...)?
- Would you prefer students to encode their own information? Would you prefer to do it by yourself? If so, what information and why?

- What characteristics do you think the interface of the system should have?

Questions about the outputs desired by coaches and tennis school principals:

- What do you want the system to provide?
- For which decisions would you like the system to provide some recommendations?

Questions the potential contribution of the system:

- Do you think that a system to help coaches in their decision-making can make a positive contribution to your business? If so, in what way? If not, why not?
- Do you think it is possible to include such a system in your daily life?

This interview allows the author to extract and analyze some of the problems and needs encountered by a tennis coach. It is also a way of collecting information and knowledge useful for designing a database or a knowledge base.

4.1.2. Analysis of Problems and Needs of Tennis Coaches

In this work, it is important to specify that the term tennis coach is used to describe several tennis related functions that can be attributed to other people. According to the answers received during the interviews, it seems that some coaches are not always in charge of certain tasks such as the composition of players' group for training, the organization of payments... These tasks are sometimes assigned to the tennis school director, the club president or a member of the board. However, it often appears that coaches have several roles (Coach and tennis school director...). Therefore, we group these different functions in coaching in order to simplify the name and structure of the system.

Based on the answers received during the interviews transcribed in the appendix (c.f. Appendix C), a description of the profile of the various coaches is provided as well as an analysis of their needs and problems. Some information such as the function, degree of training, tennis level, type of players trained or the volume of hours of tennis lessons given is grouped by coach in a descriptive sheet. A list of attributes is formed to define the coaching style of each coach. The problems and needs of each coach are identified. In order to complete the descriptive

sheet of each coach, a preliminary analysis of the methods used by each coach is carried out in order to define each coach's own coaching method.

Coach 1: Juliette Bastin

- **Function:** Tennis School Co-Director, Former Professional Tennis Player.
- **Training:** /
- **Actual Tennis Ranking:** B-15.4 (National Index: 35)³.
- **Types of trained players:** No type with preferences for competitive players.
- **Volume of hours given per week:** Very few hours to replace unavailable coaches.
- **Coach's style:** Participatory, positive and player-sensitive coaching.

Problems encountered:

- When communicating their schedules, players must not have access to coaches' availability. Indeed, this encourages students to voluntarily limit their availability to ensure that they have a specific coach.
- It often appears that players must estimate themselves their level of tennis when they contact the coach. This could be a problem because a personal estimate of the level is too subjective and often leads to the formation of groups of players with very different levels.

Needs expressed:

- The main difficulty is to be able to organize groups of players using the same type of ball, with compatible schedules and levels.

Coach 2: Marc Rousseaux

- **Function:** Tennis School Director, Full-Time Tennis Coach.

³ A description of tennis national ranking in Belgium are available in <http://www.aftnet.be/JOUEURS/Classements>

- **Training:** Level 2 of 3 of the formations provided by the Aft (*Association Francophone de tennis belge*)⁴, 20 years of experience.
- **Actual Tennis Ranking:** B-4/6⁵.
- **Types of trained players:** All types of players (competitive, leisure, children, adults...) from professional players to amateur players.
- **Volume of hours given per week:** 45-65 hours per week.
- **Coach's style:** A coaching style adapted to each player with an offensive tactic.

Problems encountered:

- It appears that his main problem is related to the parents of the players. They are often too exigent and inflexible regarding the composition of their children's group, the results in competition as well as unrealistic hourly requirements.
- Players often misjudge their levels. This is a problem because a personal estimate of the level is too subjective and often leads to the formation of groups of players with very different levels.

Needs expressed:

- A very simple tool with a simple interface to solve problems related to estimating player levels and group formation.

Coach 3: Damien Evrard

- **Function:** Tennis School Co-Director, Part-Time Tennis Coach
- **Training:** Level 1 of 3 of the formations provided by the Aft (*Association Francophone de tennis belge*)⁶, 10 years of experience.
- **Actual Tennis Ranking:** C.15⁷.

⁴ Details of the training provided by AFT are available on the website: <http://www.aftnet.be/FORMATIONS>

⁵ A description of tennis national ranking in Belgium are available in <http://www.aftnet.be/JOUEURS/Classements>

⁶ Details of the training provided by AFT are available on the website: <http://www.aftnet.be/FORMATIONS>

⁷ A description of tennis national ranking in Belgium are available in <http://www.aftnet.be/JOUEURS/Classements>

- **Types of trained players:** All types of players.
- **Volume of hours given per week:** 7-10 hours per week.
- **Coach's style:** A coaching style adapted to each player with an approach aimed at delegating to certain members of a group of players to help others improve.

Problems encountered:

- Parents of the players are often too exigent on their requests due to their lack of knowledge of the tennis world.
- Parents and players tend to overestimate their level. Groups of players will be formed based on subjectively estimated and often erroneous levels.
- Another problem is that the feeling between players is not always good, but it is quite complicated to have students at the same level, with the same availability and who get along well.

The construction of individual description sheets for each coach makes possible an objective comparison between them. This process gather information needed for a recommendation concerning several decisions such as assigning a group of students to a coach based on their characteristics.

4.1.3. Decision-Making Process of a Tennis Coach

A standard decision-making process of a tennis coach is designed to support the creation of an appropriate decision support system. The main steps in a coach's decision-making process are identified during interviews and represented in chronological order. To facilitate the development of the system, the process is expressed and assumed in a simplified way around three central decisions made by the tennis coaches:

- 1) What is a player's level and how to estimate it?
- 2) How to form groups of players in such a way as to respect all the constraints related to players?
- 3) What are the appropriate exercises for groups of players?

The first step is to collect all the basic descriptive data about a player who wants to register. Information such as a player's age or competitive objectives are essential. Then the player's level is estimated by a coach during a test day, the first training session or a specific test. Based on the player's information and level, he is placed in a group with players with similar characteristics in terms of age, schedules.... Finally, the coach plans the training sessions considering the level of the group and its characteristics.

Based on the analysis of the literature made in Part 1 of this work and the answers of interviews, creating a decision support system to help coaches seems to be the best solution because most problems, as we can see after analyzing the problems and needs encountered by coaches, are semi-structured or unstructured. Indeed, these problems do not always have a clear solution and the judgment of the coach (decision-maker) is essential in order to obtain an effective solution. According the definition of DSS of Gorry and Scott Morton (1971), using a DSS is more appropriate.

4.2. Description of the System Structure

To create the base model of the system, an agent-based architecture is used. The system is inspired by the structure of other multi-agent systems. In the literature, there are several examples of systems that combine multi-agent systems and other techniques to improve decision-making. Ponte et al (2016) developed an Intelligent Decision Support System (IDSS) for real-time water demand management that combines a Multi-Agent System (MAS) with complex real-time water demand forecasting techniques, it allows the implementation of the system in different scenarios and guarantees a great accuracy. Gong and Ling (2009) developed a table tennis player's psychology decision support system based on the Multi-Agent System. The objective of the system of Gong and Ling (2009) is to coordinate the various stakeholders (coaches, staffs and players) in all the decisions to be taken during a table tennis competition in order to make the player as competitive as possible.

According to Jennings et al. [1998], an agent is *"a computer system, situated in some environment, that is capable of flexible autonomous action to meet its design objectives"*. However, Franklin and Graesser [1997] propose a formal definition of an autonomous agent which clearly distinguishes a software agent from just any program or computer system.

Decision support systems built around a multi-agent structure have the advantage of being able to provide important information to decision makers in order to solve semi-structured and unstructured problems. Multi-agent systems are based on cooperation and coordination between agents. The advantage of such a system is that each agent is assigned to a task in the decision-making process and is independent. Each agent adapts to a change in the environment and communicates with other agents to obtain information needed to perform its task (Gong and Ling, 2009). Ponte et al (2014) highlight the fact that agents can carry out flexible and autonomous actions that affect their environment to fulfill certain objectives. Given the flexibility that a tennis coach must have in his decision-making and the wide range of elements he must take into account (player level, schedules, age...) in order to make the most effective decisions possible for his students (Group of compatible players, choice of training...), a multi-agent system seems appropriate in order to help tennis coaches.

Potential users of the system may have different profiles. The system is intended primarily for coaches and tennis school directors with enough numbers of students and coaches. However, the system can be used by a single coach leading some groups of students, but some elements and aspects of the system will be useless. A tennis coach can use the system to optimally train his own groups, but the coach's assignment based on his data will not count as he is alone. The coach can also use the system to obtain recommendations on exercises to be performed by group during a training session.

According to the information collected about the different tasks a tennis coach must perform in the decision-making process identified in the previous section (see 4.1.3), their needs and problems as well as the nature of the decisions they have to make during these different tasks, a system is designed and shown in Figure 8.

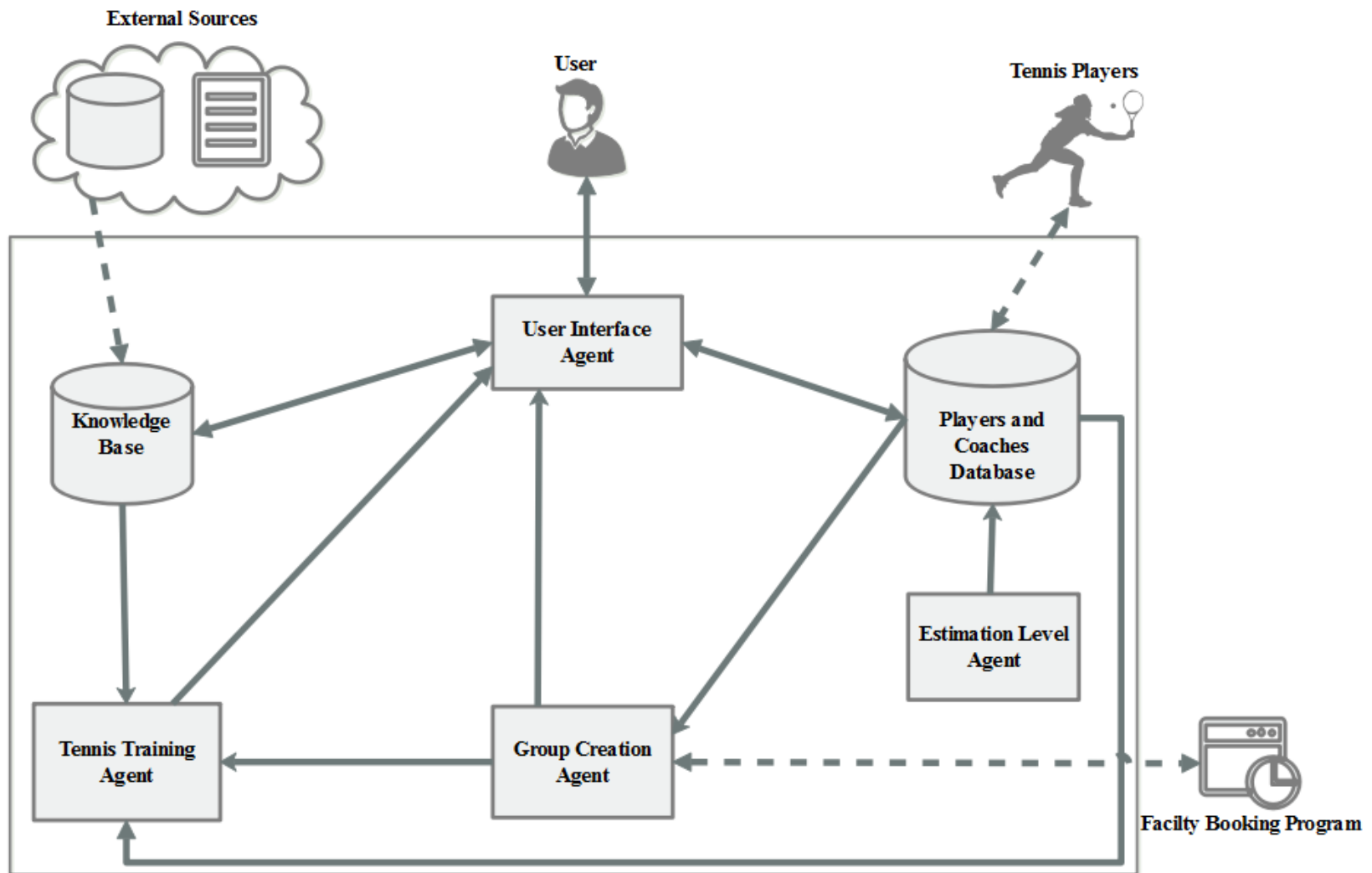


Figure 8 : Structure of the DSS for tennis coaches

Figure 8 shows an outline of the structure of the DSS that has been designed, with its agents and the relationships between them and the outside. The system is represented by the frame and composed by four agents and two data and information storage spaces:

- I. User Interface Agent
- II. Estimation Level Agent
- III. Group Creation Agent
- IV. Tennis Training Builder Agent
- V. Knowledge Base
- VI. Players and Coaches Database

There are four external elements of the system that impact the operation of the system:

- I. Tennis Players
- II. User
- III. External Sources
- IV. Facility Booking Program

It appears that the system can be defined as a hybrid decision support system even if most of its components refer to the basic structure of the DSSs. The use of a knowledge base refers to the basic structure of expert systems (Nelson Ford, 1985). The role of this system is to provide recommendations about the different decisions that a tennis coach must make. The objective of the system is therefore a mix of the objectives of DSSs and ES expressed by Nelson Ford (1985), he specifies that certain concepts of ES are transferable to the DSSs. However, it seems useful to point out that the creation of an expert system to help tennis coaches would not be optimal. Indeed, this type of system cannot manage inconsistent knowledge and does not consider judgments and intuitions (McLeod and Schell, 2004). Tennis is not an exact science and the knowledge and coaching methods are different from one coach to another as demonstrated in the previous chapter (4.1), it seems more appropriate to opt for a more flexible system (as DSS) designed to manage inconsistency.

The system inputs are of different forms (data, information or knowledge) and come from different sources represented by the four elements outside the system (the users, the players, the external sources and the facility booking program). The system outputs are the set of recommendations provided by the system agents. A precise description of the outputs

provided by the system is given in section 4.2.3. The relationships between the different elements of the system and the external elements are represented by unidirectional or bidirectional arrows in Figure 8. The direction of the arrows represents the direction of data and information flows between the elements. In order to explain the nature of the relationships between the elements represented in Figure 8, it is necessary to describe in detail the function of each element of the system. The technical description of the composition of the system elements is provided in the following section (4.2.2) to explain how the elements fulfill their objectives. It should be highlighted that this is a pilot system, where some simplified assumptions have been adopted.

4.3. Technical Description of the System Elements

This section aims to describe as accurately as possible the purpose, composition and relationships with other elements of the system of each system entity. However, it should be noted that the structure of the system as well as the composition of its elements are only an initial outline of what a functional decision support system for tennis coaches could be. This system is intended to be used as a development basis for a more elaborate system.

4.3.1. User Interface Agent

The User uses the system via the User Interface Agent. The purpose of the user interface agent is to display and group the recommendations provided by the other agents so that they can be consulted by the user. The interface must be structured in a simple and efficient way to avoid any loss of time for the user. It also allows the user to encode all the information required by the system to make recommendations. The establishment of a two-way relationship in Figure 8 is therefore justified between the user and the interface. The User Interface Agent is in unidirectional or bidirectional relationship with each element of the system. These relationships are explained and argued in the description of the various elements of the system below.

4.3.2. **Players and Coaches Database**

Purpose

Martin and Hrycaiko (1983) observed that the use of measurable and observable data provides a scientific and solid basis for the coach to improve the behavior of a team or athlete. The Players and Coaches Database contains all the descriptive data concerning players and coaches. The database has a primary role since the Group Creation agent relies essentially on the data stored in this database to form groups. It can also be consulted in an informative way by users of the system.

Composition

Based on the interviews, it is possible to define a list of data to be collected on players and coaches. The database contains basic data about the players⁸:

- Last name
- First name
- Age
- Sex
- Address
- Telephone number
- E-mail
- Names of parents or legal guardians
- Competitive Player (Y/N)⁹

Some essential additional data on players are included in the database:

- Time slots per hour and per day when players are available
- Preferences regarding the number of players desired in the group

⁸ This list is non-exhaustive and can be modified to meet the user's requirements.

⁹ Yes: If the player wants to do tennis in competition/No: If the player wants to play tennis as a hobby.

- Preferences regarding other members of the training group
- Preferences regarding the coach
- Level of the player estimated by the Estimation Level Agent ($Level_{Name}$) associated with the category associated with the value of $Level_{Name}$ (see 4.3.3.)
- Scores obtained per player for the different variables (V_i) for the Estimation Level process (see 4.3.3.)

The database contains basic data about coaches¹⁰:

- Last name
- First name
- Age
- Sex
- Address
- Telephone number
- E-mail
- Formation level
- National tennis ranking

Some essential additional data about coaches are included in the database:

- Time slots per hour and per day when coaches are available
- Preferences regarding the size of groups to be trained (1,2,3 or 4 players)
- Preferences regarding the type of player to be trained (Age, Level, Sex)

Relationship with other elements of the system

Based on the requests and problems expressed by the coaches during the interviews, the players are asked to enter their personal data themselves (except their level of play calculated by the user via the Estimation Level Agent). Players have restricted access to the system database; they can modify their data and consult it. This justifies the two-way

¹⁰ This list is non-exhaustive and can be modified to meet the user's requirements.

relationship between Players and Players and Coaches Database in Figure 8. The User uses the user interface to encode the data corresponding to the players (if the players haven't done it by themselves) as well as their personal data and schedules as a coach. In the case where the User oversees managing several coaches (Example: Tennis school director), he is authorized to encode, modify and consult the data of the other coaches. The database sends the necessary data to the Group Creation agent to create groups of players. The database receives the estimation of the level of each player of the Estimation Level Agent as a quantitative variable with the value of the different variables used to estimate the player's level. The database communicates all variables estimating a student's level to the Tennis Training Agent so that he can build training adapted to the players' level.

4.3.3. Estimation Level Agent

Purpose

The Estimation Level Agent determine a player's level. Indeed, it appears that groups of players are formed on player levels. According to the coaches interviewed, this often seems to be a problem. Indeed, players are often required to estimate their level by themselves when they register. A subjective estimation of the level causes large differences between players in the groups. In order to enable coaches to estimate the players' level as objectively as possible, the Estimation Level Agent calculates it quantitatively based on variables identified during the interviews. This method can be used to compare the level of players with each other.

Composition

The agent proposes a table containing 10 variables identified by the coaches interviewed as the tennis aspects that make it possible to estimate a player's level. These variables are represented in Table 1.

Level estimation variables ($Level_{Name}$)	Scale from 1 to 10									
	1	2	3	4	5	6	7	8	9	10
Physical level (V_1)										
Forehand technique (V_2)										
Backhand technique (V_3)										
Service technique (V_4)										
Volley technique (V_5)										
Competitiveness level (V_6)										
Psychomotricity (V_7)										
Motivation (V_8)										
Mental Implication (V_9)										
Tactical Level (V_{10})										

Table 1: Decision variables for estimating a player's level

When the system user is asked to estimate a player's level (during a test day, during the first training session...), the user estimates the level of each variable on a scale from 1 to 10. In order to guide the user about the level scale, some indications about the level categories scale are given.

Five categories are defined arbitrarily according to the interview analysis:

- **Beginner:** The player gets a score between 1 and 2 for the variable. The player starts or does not master all this aspect of the game.
- **Intermediate:** The player gets a score between 3 and 4 for the variable. The player does not start and has acceptable but largely perfectible bases for this aspect of the game.
- **Confirmed:** The player gets a score between 5 and 6 for the variable. The player masters this aspect of the game.
- **Competitive:** The player gets a score between 7 and 8 for the variable. The player is very advanced in this aspect of the game.
- **Expert:** The player gets a score between 9 and 10 for the variable. The player masters totally or almost this aspect of the game.

Based on the formula (1), the level of a player is estimated, and a category is assigned to him.

$$Level_{Name} = \sum_{i=1}^N V_i \quad (1)$$

with

$$Level_{Name} \in [1, \dots, 100]$$

The $Level_{Name}$ variable corresponds to the player's level from 1 to 100 where $Name$ is the name of the estimated player.

$$i \in [1, \dots, 10]$$

V_i with i from 1 to 10 are the variables defined in Table (2). The value of $Level_{Name}$ defines the level category of the player. The different categories are expressed in Table 2.

Categories	$Level_{Name} = \dots$
Beginner	[1 – 20]
Intermediate	[21 – 40]
Confirmed	[41 – 60]
Competitive	[61 – 80]
Expert	[81 – 100]

Table 2: Level categories

When the value of $Level_{Name}$ is on an interval boundary (Ex: 20), the choice of the level category is left to the discretion of the coach.

Relationship with other element(s) of the system

The Estimate Level Agent provides players levels ($Level_{Name}$) for each player to the Players and coaches Database with all the variables V_i composing the estimation of $Level_{Name}$. Indeed, the level of a player is an essential variable for the Group Creation Agent and the user will be able to consult the estimated level of a player by making a query in the database.

4.3.4. Group Creation Agent

Purpose

It appears during the interview analysis that the one of the main decisions a coach must make is the composition of the training groups. He often seems to face many accounting problems in terms of level, schedule, age category, wishes of player's parents or emotional compatibility between the players to train. Consequently, the agent group training, which aims to form groups, has a central role in the system. The Training Group Agent has the specific objective of providing the user with the most optimal possible proposal for training groups of players associated with a coach at a defined time.

Composition

The Agent Training Group would consist of a program capable of generating solutions based on several variables under certain conditions. Indeed, it is possible to identify the data and information necessary for the formation of a group based on the answers obtained during the interviews and the analysis of the literature.

The Group Creation Agent can be represented as a succession of queries in the database in order of priority. Indeed, it seems possible to propose, based on the interviews, a common order of priority for the different coaches concerning 8 identified variables that will determine the composition of the groups of players. This order of priority can be modified by the user according to his own preferences. The order of priority of the decision variables show in Figure 9 are the age of the players determining its ball category (1), the schedules of the

players, coaches and facilities (2), the level of the players via the level category associated with $Level_{Name}$ (3), the preferences of the players or their parents regarding the number of players in the group (4), the player's willingness to make composition or not via the Competitiveness attribute in the database (5), the players' preferences regarding other members of the group (6), the players' preferences regarding the coach's identity (7) and finally the coaches' preferences about the players (8).

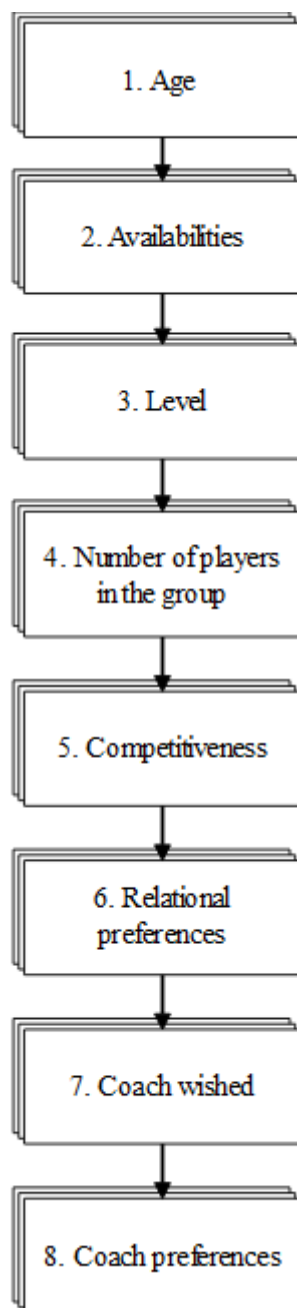


Figure 9 : Variables for deciding to create groups in order of priority

It seems interesting to detail the process of forming groups in steps corresponding to the decision variables identified in order of priority (Figure 9). The Group Creation Agent makes a query in the database based on the age of the players. Players are grouped into 4 distinct groups corresponding to the different types of balls assigned to age groups. The hardness of the balls increases according to the age of the player (5-7 years old: foam ball, 7-9 years old: soft ball, 9-11 years old: mid ball, 12-... years old: hard ball). The agent makes a query in the database to group the players into subgroups of players with the same time availability. It should be noted that a player may be in several different groups because the request is intended to create all possible groups. The agent makes a query in the database to break down all the groups formed in the previous step based on the coaches' availability. A coach may be associated with several groups. Then, a request is made in the Facility Booking Program to refine the groups based on the availability of the facilities. All groups are associated with a tennis court at a unique time slot. A query is made in the database to split the groups according to the player level categories ($Level_{Name}$). Groups with players of different levels are not an option anymore. Therefore, the groups formed at this stage of the process are only composed of players belonging to the same level category (Beginner, Intermediate, confirmed, competitive or expert), so it is possible to associate this category with the whole group. The group belongs to a level category. Additional requests by the agent are made based on the number of players in the group, whether each player in the group wants to compete or not, and finally on the coach's preferences.

At the end of the process, the agent is supposed to display a set of groups in the interface. The ideal scenario is that players are grouped together to play with the same type of ball, at times that optimize the time slots of the facilities with a chosen coach who appreciates the type of player in his group. The players in each group are also of the same level and have the same objectives regarding the competition. This scenario is more than improbable, which is why it is important to specify that if during a group refining step, a player is only present in one group, this group is proposed to the user with these characteristics. It remains for the coach to decide based on this recommendation (i.e. Merge with another group, place the player with players of different levels...).

There are several aspects that are considered in the formation of groups that are difficult to modulate. All coaches have specified the importance of flexibility in tennis player coaching. They are required to estimate the compatibility of players to create groups. Placing

some players together even if all the decision variables are favorable to the association of these players may be non-productive if the players do not appreciate each other. Therefore, it should be remembered that the coach can change the composition of the groups at his discretion.

Relationship with other elements of the system

The Group Creation agent makes queries in the database of Players and coaches to obtain the data and information necessary to create groups of players. It consults information on the availability of facilities (tennis courts) in the Facility Booking program and books time slots according to the groups formed to justify the two-way relationship in Figure 8. The agent forwards the formed group proposals to the user interface for consultation by the user and to the Training Group agent to provide training session suggestions adapted to the group's characteristics.

4.3.5. Knowledge Base

Purpose

The Knowledge Base contains a set of knowledge related to the compositions of tennis training sessions. The objective of the knowledge base is to gather as much knowledge as possible about the training methods of the different aspects of tennis in order to provide a basis for the Tennis Training Agent who creates training adapted to each group of players. The knowledge base can be represented with a search engine that allows the system and external users to search for specific exercises and trainings.

Composition

The Knowledge Base is composed by sets of exercises and training programs grouped together and sorted into several categories. These categories correspond to the different level categories specified in section 4.3.3 (Beginner, Intermediate, Confirmed, Competitive, Expert). These categories are composed of sub-categories representing some of the aspects of the game:

- Technique
- Tactic

- Physical
- Mental
- Pleasure and fun
- Competitiveness

Each category includes also different sub-categories to provide a higher level of specificity in the research. These categories are composed of exercises and programs characterized by the 10 variables (V_i) used to estimate a player's level (see section 4.3.3.) and the age range for which the exercises are designed. Indeed, some exercises are not suitable for children or adults and vice versa. The Technical sub-category contains exercises to work on forehand technique, backhand technique, service technique, volley technique and psychomotricity. The Tactical sub-category contains exercises to improve tactics. The Physical sub-category contains all the exercises to work on the physical. The Mental sub-category contains all the exercises designed to strengthen the players' minds and the Competitiveness sub-category contains exercises designed to stimulate the spirit of competition for players wishing to compete. Finally, the Pleasure and Fun category is special because it consists of exercises with a playful character.

Coaches and system users are invited to define the aspects that the exercises they introduce into the Knowledge Base will train based on the 10 variables used to estimate a player's level (see section 4.3.3.) and the associated age. It is possible that some exercises are referenced in several categories because some exercises are designed to work on different aspects of the game (Example: An exercise to work on the forehand technique by incorporating mental constraints). The exercises and training sessions are stored in different file formats (.txt,.png,...).

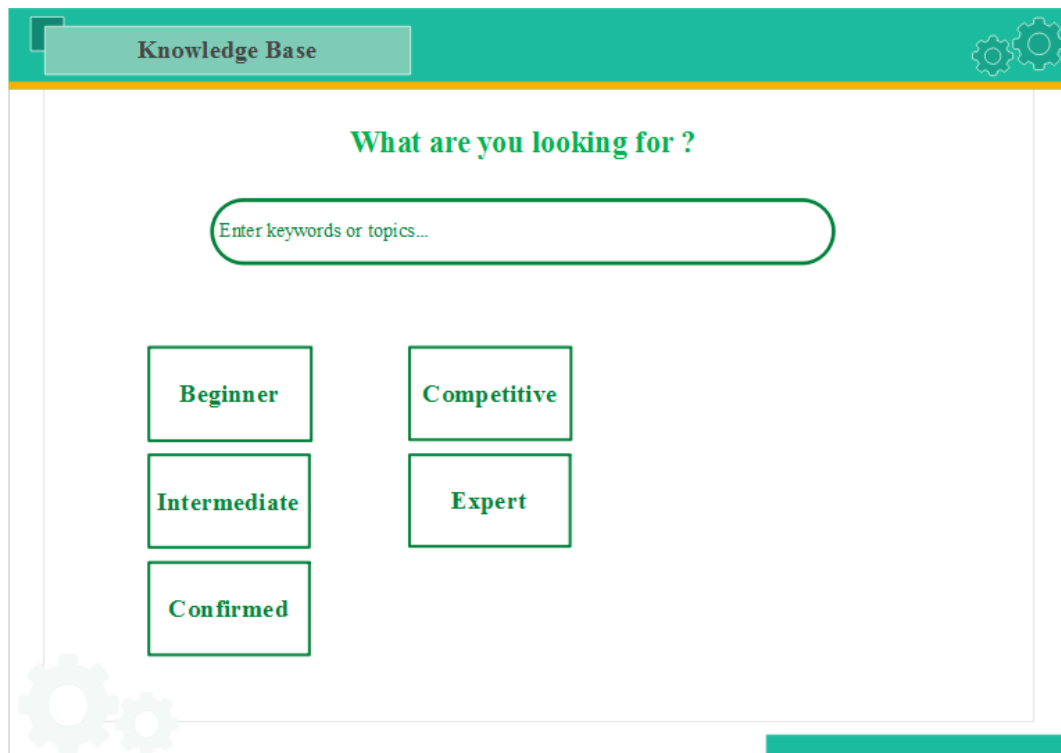


Figure 10: Interface of the Knowledge Base

The interface of the Knowledge Base is represented in Figure 10 where a search bar is available for the user to enter keywords about the exercises he is looking for. The different categories are also presented in such a way as to guide the user. The Knowledge Base can be considered as human readable and machine readable. The knowledge base is human readable because it enables people (the User) to access and use the knowledge and machine readable because knowledges are stocked in system readable forms for the Tennis Training Agent (Techopedia.com, 2019).

Relationship with other elements of the system

The Knowledge Base has two sources of knowledge. The first source is the user of the system who incorporates all the exercises and trainings he created by describing the aspects that are worked on in it. This allows the knowledge base to classify them into the right category or categories. The User can also consult directly the Knowledge Base, which justifies the bidirectional relationship expressed in Figure 8. The second source is represented in Figure 8. by all external sources. These external sources include all sources external to the system that can provide tennis training exercises. These sources can be reference books of coaching, trainings given to coaches by tennis federations, exercises on the internet, etc. The exercises and trainings from external sources are regularly updated by the system designer. The

Knowledge Base responds to the requests made by the Tennis Training agent by transmitting all the exercises corresponding to the search.

4.3.6. Tennis Training Agent

Purpose

The tennis training agent aims to offer the user exercises and training adapted to the characteristics of each group of players. The agent uses the group level category and the strengths and weaknesses of the players to query the knowledge base containing a multitude of exercises. It aims to avoid users having to search for exercises corresponding to the characteristics of each group by themselves.

Composition

The tennis training agent is composed of a program containing a set of predefined queries to query both the database and the knowledge base in order to associate a list of exercises and training adapted to each group. The agent uses the groups formed by the Creation Group agent as well as the level category to which the group belongs. It makes a query in the database to obtain details of the variables used to estimate the level of each player in the group. It is interesting to consult the different variables (V_i in the equation 1, see section 4.3.3.) in order to identify the weak points of the players in the group. By doing this, the tennis training agent will be able to refine his query in the knowledge base in order to look for exercises to work on the weak points of the group. Obviously, it is possible that the players in the group may not have the same weak points, this is not a problem because the tennis training agent makes a request to find exercises to work on the different weak points at the same time. If this type of exercise is not in the knowledge base, the tennis training agent proposes exercises to improve the weak point(s) of one part of the group while knowing that the other part of the group is more effective on these attributes. It is possible to illustrate this situation by imagining that in a group of 4 players, 3 players have a rather poor forehand technique and the last member of the group has a better technique than the others. According to the coaches interviewed, the player with the best technique will inspire others to improve. Therefore, the exercises offered by the tennis training agent should not always be designed to work on weak points. In the hypothetical case where players in the same group have no common weaknesses, the tennis training agent will

offer a set of random exercises to the user. This gives ideas to coaches who may be lacking inspiration.

Relationship with other elements of the system

The Tennis Training agent receives the group compositions from the Group Creation agent. It receives the essential data from the Players and Coaches database concerning the weak and strong points as well as the descriptive data (age, willingness to compete...) of each player. He also receives the exercises corresponding to his detailed request from the knowledge base. Finally, the Tennis Training agent transmits a selection of exercises adapted to the characteristics of each group created by the Group Creation agent to the User Interface agent.

4.4. Possible Contribution of the System Outputs

The system provides several outputs to the user and these are intended to assist the user in his decision-making process. However, the system provides 3 outputs to help the user in making major decisions such as estimating the level of players, composing training groups and choosing the exercises that make up group training. The system provides a quantitative method that allows coaches to estimate the level of players in a more objective way. This system contributes to faster and more effective decision-making about a player's level. It allows to reduce problems related to subjective estimation of players level. The system also provides a proposal for group composition based on all the elements taken into account to form groups in order of importance. This avoids the need for users to form groups manually and helps to reduce the risk of forming incompatible groups of players. The last major output of the system is the proposal of training sessions adapted to the characteristics of the training groups. This aspect of the system allows users to get an idea of the kind of exercises they could implement during training.

It appears from the interviews that the coaches interviewed believe that such a system with a simple, streamlined and efficient interface could save them a lot of time and help them make better decisions. They point out that it is possible to use such a system particularly in large tennis structures.

5. Conclusion

Tennis coaches, like any manager in any business, make a daily set of decisions with various and varied objectives and constraints in order to achieve the best possible result. It is assumed that tennis coaches encounter problems when they must decide. Based on this observation, this work aims to develop a computer system with the objective of providing recommendations about the choices coaches face.

In order to collect information about the job of tennis coach, interviews were conducted with three coaches with different profiles. The interview questions were constructed based on a detailed analysis of the literature on decision-making in sport. Three major decisions have been identified that coaches must make under pressure. They must estimate a player's level, form groups of players and decide on the composition of the training sessions. These decisions often seem to be submitted to the coaches for assessment. As a result, it is difficult to identify a defined process for making the optimal decision. However, there are different types of decision support systems composed of elements that provide recommendations to solve semi or unstructured problems. Following a detailed analysis of the literature on the components and objectives of the different types of decision support systems, it appears that the use of a DSS seems to be appropriate for the characteristics of the decisions that a tennis coach must make. Indeed, this type of system aims to support the user in his decision making.

The decision support system for tennis coaches proposed in this work can be characterized as a hybrid system. Indeed, it is a multi-agent system composed of 3 main agents linked to a knowledge base and a database acting as internal data sources. The contribution of this system lies in the way in which each agent makes his or her recommendations. An agent provides a method for quantitatively assessing a player's level. This allows coaches to compare players' levels in a less subjective way. An agent forms the groups of players in order of priority regarding the decision variables. The decision variables and their order of importance were identified based on the interviews. The last agent aims to create exercises that are as adapted as possible to the characteristics of each group. The contribution of such an agent allows coaches to train players more effectively.

Such a system would allow coaches to make better decisions. However, it is important to specify that this system is not intended to provide decision support and under no

circumstances to take a decision in the place of the coach. Indeed, there are many aspects, especially emotional aspects, that are considered in decision-making that cannot be modelled in the system. The coach is responsible for the final decision and has full freedom to go against the system's recommendations.

It should be highlighted that this is a preliminary work or pilot system, where some simplified assumptions have been adopted. Consequently, some ideas for consideration regarding the directions to be taken to improve the system are expressed below.

5.1. Further work

The estimation of the system's contribution is relative without the implementation of a test phase with the coaches. Therefore, the first step would be the development and the implementation of the system. It would be interesting to build and implement the system database and knowledge base in order to test the system queries.

Some elements of the system can be improved. The agent aims to estimate a player's level by assuming that all the variables used to estimate a player's level are equally important for all coaches. However, it appears that some coaches will give more importance to variables over others. Therefore, incorporating coefficients for each variable would allow the importance of each variable to be modified according to the user's wishes. The advantage of the multi-agent structure of the system is that it is possible to incorporate additional techniques and tools to each agent. The system is technically upgradeable and modular.

The competitive aspect of tennis is a concept that has often been mentioned in interviews with experts, as well as the affinities between players and coaches. It seems complicated to add elements to the system to consider something as ambiguous as the players' emotions. This must be at the coach's discretion. However, it seems possible to incorporate parameters into the training agent to take into consideration future player competitions in order to make optimal recommendations regarding training planning.

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Appendix

Appendix A

Table 1. Features of Naturalistic Decision Making

1. Ill-defined goals and ill-structured tasks
2. Uncertainty, ambiguity, and missing data
3. Shifting and competing goals
4. Dynamic and continually changing conditions
5. Action-feedback loops (real-time reactions to changed conditions)
6. Time stress
7. High stakes
8. Multiple players
9. Organizational goals and norms
10. Experienced decision makers

Table 1: Feature of Naturalistic Decision Making (Klein and Klinger 1991)

Appendix B

DSS Type	Frequency	Percentage
Personal DSS (includes modelling & analytics)	106	29.6
Group Support Systems	88	24.6
EIS (includes BI & OLAP)	30	8.4
Data Warehouse	60	16.8
Intelligent DSS	33	9.2
Knowledge Management based DSS	2	6.0
Negotiation Support Systems	18	5.0
Many	21	5.0
Total	358	

Table 2: Frequency of research by DSS's type

Appendix C

C.1. Interview Juliette Bastin (coach 1)

Questions visant à obtenir des informations sur la personnalité du coach et ses méthodes de coaching :

⇒ **Comment décririez-vous votre fonction dans le monde du tennis ?**

Je suis joueuse de tennis depuis l'âge de 6 ans. Je me suis entraînée environ 10 heures par semaine depuis l'âge de 10 ans dans différents clubs mais également à la fédération. Je suis classée actuellement B-15.4 et 35^{ème} belge. J'assume désormais le poste de co-directrice de l'école de tennis de Malonne depuis 2 ans. Je gère donc la partie administrative de l'école et je donne très peu de cours.

⇒ **Quelles sont les tâches que vous réalisez en tant que coach ?**

Comme expliqué à la question précédente, je ne donne pas vraiment de cours hormis pour remplacer un professeur en cas d'absence. Je gère l'école et les profs.

⇒ **Faites-vous partie d'une structure du style école de tennis ? Si oui, quel est votre rôle ?**

Je suis co-directrice d'une école de tennis et je m'occupe donc de l'organisation des différents cycles de cours et stages. Je traite les inscriptions, je procède à la création des groupes, j'achète le matériel nécessaire, etc. Je m'occupe également de la réservation des terrains en été et de la salle en hiver. Je suis aussi en charge de la partie financière (paiement des profs, des terrains, etc.).

⇒ **Combien d'heures de cours donnez-vous en moyenne ? Et depuis combien de temps êtes-vous coach ?**

Je donne quelques cours à l'occasion lorsqu'il faut remplacer mais ce n'est pas régulier.

⇒ **Entraînez-vous un type de joueur en particulier (jeune, adulte, débutant, confirmé...) ? Si oui, sur base de quels critères vous basez-vous pour définir le type d'un joueur ?**

Je n'entraîne pas de type de joueur en particulier cependant, je préfère entraîner des compétiteurs si j'ai le choix. Pour définir le type d'un joueur, je me base d'abord sur

son âge et sur le type de balle avec lequel il joue. En effet, avant de pouvoir jouer avec la balle de tennis que tout le monde connaît, les enfants doivent passer par différentes sortes de balle en fonction de leur âge. De 5 à 7 ans, ils utilisent une balle « feutre ». De 7 à 9 ans, ils utilisent une balle « intermédiaire » et de 9 à 11 ans, une balle « mid » est utilisée. Après avoir identifié cela, je regarde depuis combien de temps le joueur joue ou suit des cours et s'il a déjà fait des matchs.

⇒ **Quelle est votre vision du tennis (Tennis loisir, compétitif...) ? Avez-vous une approche particulière de la compétition ?**

Je dirais que ma vision de base est celle du tennis en compétition étant donné que cette dernière fait partie de ma vie depuis toute petite mais j'ai également pu acquérir une vision de tennis loisir grâce aux autres membres de ma famille qui pratiquent le tennis en loisir. Mon approche de la compétition est plutôt caractérisée par le stress et la pression qu'elle engendre mais le fait de reprendre l'école de tennis de Malonne et de suivre parfois certains élèves en compétition, a rendu cette approche plus familiale. Malgré cela, la compétition reste pour moi primordiale à l'évolution d'un joueur. C'est en faisant des matchs et en ayant un esprit de compétiteur que le joueur évoluera.

⇒ **Pouvez-vous décrire votre implication et votre expérience en compétition en tant que coach ?**

Mon expérience en tant que coach est assez restreinte mais j'ai quand même déjà eu l'occasion de suivre quelques élèves dans des tournois de jeunes. Je m'implique en regardant chaque point du match et en encourageant les élèves le plus possible. Après le match, il est important de réaliser un petit débriefing avec l'élève afin de mentionner les points positifs et négatifs du match.

⇒ **Quelles sont les principales caractéristiques qu'un coach doit posséder afin d'amener ses joueurs compétitifs ou non à s'améliorer ?**

Une caractéristique très importante en tant que coach est selon moi de toujours rester positif. Il faut également avoir de la confiance en ses joueurs. Le fait d'avoir aussi une bonne expérience dans la compétition aidera à orienter ses élèves vers des choix judicieux.

⇒ **Comment définiriez-vous votre style de coaching (Autoritaire, participatif ou délégatif) ? Adaptez-vous votre style en fonction du joueur ?**

Mon style de coaching est assez participatif car je pars du principe que le coach est là pour son joueur et qu'il doit toujours être à l'écoute de ses besoins et/ou envies. Le fait de participer en jouant avec ses élèves peut les mettre en confiance et donne une certaine fierté à ceux-ci. Selon moi, il est évident de s'adapter à son joueur. Chaque personne est différente et il faut parvenir à comprendre le fonctionnement de chacun. Par exemple, lorsqu'un élève traverse une mauvaise passe, pour certains, il faudra que le coach lui donne une bonne leçon pour qu'il y ait une réaction positive, alors que cette méthode ne ferait qu'enfoncer d'autres.

⇒ **Quelle est la place de la technique et de la tactique dans vos méthodes d'enseignement ?**

Tout dépend des objectifs et ambitions des joueurs. Il est clair que la technique fait partie de la base de l'apprentissage du tennis mais elle peut toujours être améliorée même chez les compétiteurs. La technique est un élément essentiel qu'il faut toujours travailler. La tactique en revanche dépend surtout du niveau des élèves. Elle ne fait d'ailleurs pas partie du programme d'un débutant. Elle devient cependant importante lorsque les élèves ont pour ambition de faire des matchs. Elle est surtout beaucoup travaillée chez les compétiteurs.

⇒ **Comment décririez-vous votre « touch » en tant que coach en quelques mots ?**

Je pense être une coach positive qui essaye toujours de donner le maximum et de s'adapter au mieux pour faire évoluer les élèves.

Questions sur les problèmes et besoins ressentis par les coaches et directeurs d'écoles de tennis :

⇒ **Quels sont les principaux problèmes rencontrés au quotidien liés à votre profession ?**

En tant que directrice d'école, la principale difficulté est de pouvoir organiser des groupes d'élèves utilisant les mêmes balles, ayant les mêmes disponibilités et le même niveau. En parlant de niveau, celui-ci pose également un problème car il est très difficile à mesurer surtout si c'est l'élève qui le détermine par lui-même à l'inscription. Un problème aussi rencontré est lorsque l'élève connaît les disponibilités de son professeur préféré. Il va dès lors réduire ses propres disponibilités, ce qui engendre beaucoup de difficultés pour la création des groupes.

Questions visant à déterminer un processus de décision standard pour les coachs de tennis :

⇒ **Quelles sont les étapes que vous suivez quand un nouveau joueur vous contacte dans l'optique de suivre des cours de tennis ?**

Je lui demande de s'inscrire sur notre site internet afin d'y entrer toutes ses coordonnées, son niveau et ses disponibilités. Après avoir récolté son inscription, nous lui faisons passer un petit test de niveau ou nous l'intégrons directement dans un groupe. Après cela, son horaire de cours ainsi que son moniteur et son groupe lui seront communiqués.

Questions visant à déterminer l'ensemble des inputs à prendre en compte dans la conception du système :

⇒ **Comment récoltez-vous les données signalétiques des élèves ?**

Auparavant, nous récoltions les données par téléphone ou par e-mail mais c'est assez compliqué et des erreurs sont parfois commises. Désormais, les élèves entrent eux-mêmes leurs données via une plateforme internet.

⇒ **Quelles sont les infos indispensables que les joueurs doivent vous communiquer ?**

Prénom, nom, date de naissance, adresse, adresse e-mail, numéro de téléphone, disponibilités, niveau, type de cours souhaité (particulier, groupe, etc.)

⇒ **Sur base de quels critères et attributs basez-vous l'évaluation du niveau d'un joueur dans l'optique de le placer dans un groupe ? (Niveau technique, niveau physique...)**

Nous nous basons surtout sur ce que le joueur nous renseigne (ce qui pose parfois des problèmes). Nous classons les niveaux en 3 types : débutant (n'a jamais suivi de cours ou seulement des stages), entraîné (joueur suivant des cours depuis 2-3 ans) et compétition (joueur suivant des cours depuis quelques années et faisant des tournois). Pour les joueurs qui ont déjà pris des cours dans notre école, nous connaissons leur niveau et nous nous basons donc sur nos connaissances (technique, sens de la balle, physique, implication, ...). Pour les nouveaux, nous essayons de repérer les différents critères mentionnés juste avant lors d'une journée test ou lors du premier cours.

- ⇒ **Quand estimez-vous le niveau d'un joueur ? Au cours d'une journée test ? Au cours d'une séance ? Prenez-vous des informations concernant le niveau d'un joueur à l'extérieur (Ancien coach du joueur...) ?**

Réponse donnée dans la question précédente.

- ⇒ **Comment collectez-vous les disponibilités des élèves et des coachs ?**

Les élèves doivent entrer eux-mêmes leurs disponibilités sur notre plateforme internet.

Pour ce qui est des coachs, nous communiquons simplement avec eux par téléphone.

- ⇒ **Comment synchronisez-vous les disponibilités des élèves avec les disponibilités des installations à votre disposition ?**

Nous ne proposons aux élèves que les disponibilités de nos installations. Ils ne pourront par exemple pas entrer qu'ils sont disponibles le dimanche si nous ne possédons pas de terrain ce jour-là.

- ⇒ **Quels sont vos critères afin de former des groupes ?**

L'âge des élèves afin de savoir dans quelle catégorie de balle ils vont être attribués.

Ensuite, le niveau qu'ils ont et les disponibilités de chacun afin de combiner le tout.

- ⇒ **Utilisez-vous d'autres critères que l'âge, le niveau et les compatibilités horaires pour former les groupes ?**

Généralement non, mais nous essayons tout de même de tenir compte des préférences des élèves pour le groupe et le moniteur mais seulement si les autres critères mentionnés plus haut sont respectés.

- ⇒ **Est-ce que la personnalité et les préférences d'un coach entre en compte lors de l'attribution des groupes à un coach ?**

Réponse donnée à la question précédente.

- ⇒ **Comment déterminez-vous les exercices qui composent les entraînements ?**

En tant que gestionnaire de l'école, je laisse les moniteurs décider des exercices qui composent les entraînements. Il serait cependant judicieux d'imposer un thème pour chaque semaine ou période de cours.

- ⇒ **Quelle est la part de création dans les exercices effectués à l'entraînement ? Quelles sont vos sources d'inspiration afin d'organiser une séance d'entraînement optimale ?**

Les cours donnés par l'AFT (Association Francophone de Tennis), les exercices qui m'ont déjà été donnés lors de mes propres entraînements et les idées des autres moniteurs. La part de création est tout de même très importante afin de diversifier les exercices et de les rendre le plus ludique possible.

Questions visant à déterminer la forme de l'interface utilisateur :

- ⇒ **Comment voudriez-vous encoder l'ensemble des informations concernant les joueurs ? Sur quel(s) type(s) de support(s) (tablette, smartphone...) ?**

Le mieux est que ce soit possible sur tout type de support donc sur un ordinateur mais également sur un smartphone et une tablette.

- ⇒ **Préfériez-vous que les élèves encodent eux-mêmes leurs infos ? Ou préféreriez-vous le faire par vous-même ? Si oui, quelles informations et pourquoi ?**

Le plus simple est que les élèves encodent eux-mêmes leurs infos de « base » et que les coachs puissent simplement ajouter des informations concernant le niveau et la progression de l'élève.

- ⇒ **Quelles sont les caractéristiques que doit posséder l'interface d'un système visant à vous aider ?**

Il faudrait qu'il soit assez simple d'utilisation (pour pouvoir l'utiliser directement sur le terrain par exemple) mais tout de même complet.

- ⇒ **Que pensez-vous d'un tableau avec des jauges à augmenter pour les différentes variables permettant d'estimer le niveau d'un joueur ?**

C'est une bonne idée, pour autant que les niveaux de la jauge soient bien définis et que ce soit assez facile pour le coach de décider si l'élève augmente son niveau dans la jauge ou pas.

Questions sur les outputs désirés par les coachs et directeurs d'école de tennis :

- ⇒ **Que désirez-vous que le système vous procure ?**

Que les moniteurs puissent avoir accès aux données des élèves et qu'ils puissent les modifier et que le système mette en lien les données des élèves par rapport aux disponibilités, aux niveaux, aux préférences, etc. pour la formation des groupes. Ce serait bien aussi que le système puisse proposer des séances de cours toutes faites en fonction du niveau et de l'âge des joueurs pour que les coachs aient d'autres idées et qu'ils puissent varier les entraînements.

⇒ **Pour quelles décisions voudriez-vous que le système vous fournisse une aide en priorité ?**

Pour les décisions concernant le niveau des élèves afin qu'il y ait le moins de changement de groupe possible.

Questions visant à déterminer l'intérêt et l'apport éventuel du système :

⇒ **Pensez-vous qu'un système visant à aider les coachs dans leurs prises de décision peut avoir un apport positif sur votre métier ? Si oui, de quelle manière ? Si non, pourquoi ?**

Oui, évidemment ! Il ferait gagner un temps fou aux gestionnaires d'écoles de tennis et il permettrait aux moniteurs d'être plus performants.

⇒ **Pensez-vous qu'il est envisageable d'inclure un tel système dans votre quotidien ?**

Oui étant donné que notre école est tout de même assez importante et que nous sommes une équipe de plusieurs profs relativement jeunes. Ce serait peut-être moins utile pour une toute petite structure.

C.2. Interview Marc Rousseaux (coach 2)

Questions visant à obtenir des informations sur la personnalité du coach et ses méthodes de coaching :

⇒ **Comment décriez-vous votre fonction dans le monde du tennis ?**

Je suis directeur de l'école de tennis de Ciney et coach à temps plein.

⇒ **Quelles sont les tâches que vous réalisez en tant que coach ?**

En tant que coach, je m'occupe de la planification de la saison de tennis des joueurs ; tout ce qui est entraînements, tournois, déplacements, ...

Pour ce qui est de l'école de tennis, je remplis une fiche technique pour chaque joueur en fonction de ses compétences (mental, physique, tennis). J'y mets des cotations et des commentaires dans le but de savoir vers quoi il veut se diriger.

⇒ **Faites-vous partie d'une structure du style école de tennis ? Si oui, quel est votre rôle ?**

Comme dit précédemment, je suis directeur d'une école de tennis.

⇒ **Combien d'heures de cours donnez-vous en moyenne ? Et depuis combien de temps êtes-vous coach ?**

Cela varie en fonction des semaines mais je donne entre 45 et 65 heures par semaine et je suis coach depuis 20 ans.

⇒ **Entraînez-vous un type de joueur en particulier (jeune, adulte, débutant, confirmé...) ? Si oui, sur base de quels critères vous basez-vous pour définir le type d'un joueur ?**

Non, j'entraîne tout le monde. Pour définir le type d'un joueur, comme j'ai déjà dit, je fais une fiche technique sauf si ce sont des nouveaux élèves. Dans ce cas, j'organise une journée de test et je me base d'abord sur l'habilité de la personne.

⇒ **Quelle est votre vision du tennis (Tennis loisir, compétitif...) ? Avez-vous une approche particulière de la compétition ?**

J'ai une vision plutôt globale mais à choisir, plutôt dirigée vers la compétition. Je n'ai pas d'approche particulière, je commence et puis j'avance petit à petit avec chaque joueur en fonction des objectifs définis au début de l'année. Ces objectifs sont parfois modifiés en cours d'année en fonction de l'avancement de la saison mais aussi des blessures (toujours en tenir compte).

⇒ **Pouvez-vous décrire votre implication et votre expérience en compétition en tant que coach ?**

J'ai suivi des joueurs sur tous les circuits qui existent, en allant du circuit régional jusqu'à celui de l'ATP ou encore de la WTA mais aussi sur le circuit « Tennis Europe » (- de 12 ans, - de 14 ans et – de 16 ans) et sur le circuit « ITF juniors » (- de 18 ans).

- ⇒ **Quelles sont les principales caractéristiques qu'un coach doit posséder afin d'amener ses joueurs compétitifs ou non à s'améliorer ?**

Il doit être capable de s'adapter à chaque joueur et d'être flexible. Il arrive souvent que certains coachs soient très bons mais ne parviennent pas à s'adapter au joueur. Ce sera donc très difficile de le faire évoluer.

- ⇒ **Comment définiriez-vous votre style de coaching (Autoritaire, participatif ou délégitif) ? Adaptez-vous votre style en fonction du joueur ?**

C'est toujours une question d'adaptation au joueur.

- ⇒ **Quelle est la place de la technique et de la tactique dans vos méthodes d'enseignement ?**

Je fais beaucoup de technique à la base, mais également avec les joueurs confirmés. C'est important de refaire des séances de technique car lorsque les joueurs sont en compétition, il arrive souvent qu'ils se dérèglent techniquement, ce qui a des conséquences sur la tactique. Je pense donc que la technique passe avant la tactique même si beaucoup de gens travaillent davantage sur la tactique. Je pense qu'il y a toujours des choses à remettre en place et à tous les âges.

- ⇒ **Comment décririez-vous votre « touch » en tant que coach en quelques mots ?**

Je suis plutôt sur des filières de jeu offensives avec des joueurs qui vont chercher les points vers l'avant car c'est beaucoup plus facile d'être positif en gagnant des points qu'en contrant et en attendant la faute de l'adversaire. Je suis donc pour le jeu positif.

Questions sur les problèmes et besoins ressentis par les coachs et directeurs d'écoles de tennis :

- ⇒ **Quels sont les principaux problèmes rencontrés au quotidien liés à votre profession ?**

Mon principal problème est en lien avec les parents. Surtout pour ce qui concerne la gestion des groupes, des compétitions, des horaires ... Ils sont aussi très exigeants par rapport aux résultats de leurs enfants.

En ce qui concerne la gestion de l'école de tennis, le problème le plus récurrent est que les familles veulent avoir cours tous en même temps et donc à la même heure mais sans

être dans le même groupe. Cela devient donc très compliqué. Un autre problème que j'observe est lorsque les joueurs me communiquent leur niveau, ça ne reflète pas toujours la réalité.

Questions visant à déterminer un processus de décision standard pour les coachs de tennis :

⇒ **Quelles sont les étapes que vous suivez quand un nouveau joueur vous contacte dans l'optique de suivre des cours de tennis ?**

Je demande aux gens de m'envoyer un mail comprenant les coordonnées mais surtout le programme qu'ils désirent avoir (pour les joueurs en compétition). Pour les nouveaux joueurs, je fais passer une journée test et sur base de celle-ci, je crée les groupes et je planifie les entraînements.

Questions visant à déterminer l'ensemble des inputs à prendre en compte dans la conception du système :

⇒ **Comment récoltez-vous les données signalétiques des élèves ?**

Via mon site internet. Les gens doivent y entrer toutes leurs infos afin que je puisse les consulter très rapidement.

⇒ **Quelles sont les infos indispensables que les joueurs doivent vous communiquer ?**

Prénom, nom, date de naissance, adresse, adresse e-mail, numéro de téléphone, disponibilités, niveau, type de cours souhaité (particulier, groupe, etc.)

⇒ **Sur base de quels critères et attributs basez-vous l'évaluation du niveau d'un joueur dans l'optique de le placer dans un groupe ? (Niveau technique, niveau physique...)**

Je regarde comment le joueur se déplace sur le terrain, comment il touche la balle donc plutôt par rapport à la psychomotricité et au physique. J'essaye aussi de percevoir la motivation du joueur même si ce n'est pas toujours évident à déterminer surtout qu'elle peut aussi varier et évoluer en fonction du groupe dans lequel le joueur sera placé.

- ⇒ **Quand estimez-vous le niveau d'un joueur ? Au cours d'une journée test ? Au cours d'une séance ? Prenez-vous des informations concernant le niveau d'un joueur à l'extérieur (Ancien coach du joueur...) ?**

Oui, nous essayons un maximum de voir tout le monde au cours d'une journée test pour que tout soit en ordre lors du premier cours. Une fois que les groupes sont faits, ça devient compliqué de faire des modifications surtout avec autant d'élèves. Il m'arrive de demander des informations aux anciens coachs mais seulement pour les élèves qui font de la compétition.

- ⇒ **Comment collectez-vous les disponibilités des élèves et des coachs ?**

Les élèves doivent entrer eux-mêmes leurs disponibilités sur mon site internet une fois qu'ils ont choisi leur formule de cours. Pour les coachs, je communique directement avec eux et ont établi le programme ensemble.

- ⇒ **Comment synchronisez-vous les disponibilités des élèves avec les disponibilités des installations à votre disposition ?**

Je fais ça manuellement étant donné que c'est mon école de tennis.

- ⇒ **Quels sont vos critères afin de former des groupes ?**

Il faut qu'ils soient homogènes et que les élèves s'entendent bien ensemble. Même si les niveaux dans un groupe ne sont pas toujours exactement les mêmes, l'important est que l'ambiance y soit. Pour les joueurs compétitions, il arrive que certains doivent absolument jouer avec d'autres pour une question de niveau mais ils ne s'entendent pas toujours étant donné qu'ils sont plus souvent adversaires que partenaires. C'est donc un peu plus difficile de les faire évoluer.

- ⇒ **Utilisez-vous d'autres critères que l'âge, le niveau et les compatibilités horaires pour former les groupes ?**

Oui, comme expliqué dans la question précédente, l'entente entre les joueurs.

- ⇒ **Est-ce que la personnalité et les préférences d'un coach entre en compte lors de l'attribution des groupes à un coach ?**

Oui mais je le fais par moi-même. Je connais bien mes moniteurs et je sais quels élèves je dois leur attribuer.

⇒ **Comment déterminez-vous les exercices qui composent les entraînements ?**

On fait un programme au début de l'année par catégorie de niveau (débutant, intermédiaire, compétition) et on le fait évoluer au fur et à mesure de l'année. Parfois il faut un petit peu reculer et parfois avancer en le complexifiant mais on part avec un schéma de base en début d'année.

⇒ **Quelle est la part de création dans les exercices effectués à l'entraînement ? Quelles sont vos sources d'inspiration afin d'organiser une séance d'entraînement optimale ?**

Je dirais entre 25 et 30 pourcents mais il est clair qu'on ne peut pas réinventer le tennis. On reste toujours plus ou moins dans le même style d'exercices dans la compétition et ils sont indispensables (comme faire des diagonales par exemple). Après 20 ans en tant que coach, j'essaie souvent de me remettre en question car il est difficile d'être tout le temps au top surtout lorsque je travaille avec les mêmes élèves depuis longtemps. J'essaie de m'adapter et de prendre de l'inspiration partout où je peux en trouver.

Questions visant à déterminer la forme de l'interface utilisateur :

⇒ **Comment voudriez-vous encoder l'ensemble des informations concernant les joueurs ? Sur quel(s) type(s) de support(s) (tablette, smartphone...) ?**

Je préfère sur un ordinateur pour avoir une vue d'ensemble avec un double écran pour pouvoir jongler facilement avec toutes les informations. Je trouve que ce serait trop petit sur un écran de smartphone.

⇒ **Préfériez-vous que les élèves encodent eux-mêmes leurs infos ? Ou préféreriez-vous le faire par vous-même ? Si oui, quelles informations et pourquoi ?**

Je préfère qu'ils le fassent eux-mêmes pour une question de facilité.

⇒ **Quelles sont les caractéristiques que doit posséder l'interface d'un système visant à vous aider ?**

Il faut qu'il soit clair et comme expliqué juste avant, qu'il y ait différents onglets et qu'on puisse les mettre en parallèle sur un double écran par exemple.

⇒ **Que pensez-vous d'un tableau avec des jauges à augmenter pour les différentes variables permettant d'estimer le niveau d'un joueur ?**

C'est une très bonne idée et ça peut être intéressant.

Questions sur les outputs désirés par les coachs et directeurs d'école de tennis :

⇒ **Que désirez-vous que le système vous procure ?**

Tout ce que j'ai déjà dit auparavant.

⇒ **Pour quelles décisions voudriez-vous que le système vous fournisse une aide en priorité ?**

Pour la formation des groupes qui dépend évidemment du niveau des joueurs.

Questions visant à déterminer l'intérêt et l'apport éventuel du système :

⇒ **Pensez-vous qu'un système visant à aider les coachs dans leurs prises de décision peut avoir un apport positif sur votre métier ? Si oui, de quelle manière ? Si non, pourquoi ?**

Oui, c'est intéressant pour tout le monde et ça permettrait de gagner du temps.

⇒ **Pensez-vous qu'il est envisageable d'inclure un tel système dans votre quotidien ?**

Oui sans problème.

C.3. Interview Damien Evrard (coach 3)

Questions visant à obtenir des informations sur la personnalité du coach et ses méthodes de coaching :

⇒ **Comment décririez-vous votre fonction dans le monde du tennis ?**

Je suis co-directeur de l'école de tennis de Malonne et entraîneur niveau 1 (Initiateur).

⇒ **Quelles sont les tâches que vous réalisez en tant que coach ?**

Analyser le niveau de l'élève, essayer d'avoir une bonne relation avec celui-ci et puis commencer à travailler sur l'aspect tactique et technique.

- ⇒ **Faites-vous partie d'une structure du style école de tennis ? Si oui, quel est votre rôle ?**

Je suis co-directeur d'une école de tennis et je m'occupe donc de la gestion des cycles de cours, de faire les groupes en fonction des niveaux et des disponibilités des élèves, etc. Je suis également moniteur.

- ⇒ **Combien d'heures de cours donnez-vous en moyenne ? Et depuis combien de temps êtes-vous coach ?**

Je donne environ entre 7 et 10 heures de cours par semaine depuis 10 ans. Les 2 premières années, j'ai commencé par donner des stages. A partir du mois de septembre, je donnerai environ 25 heures par semaine.

- ⇒ **Entraînez-vous un type de joueur en particulier (jeune, adulte, débutant, confirmé...) ? Si oui, sur base de quels critères vous basez-vous pour définir le type d'un joueur ?**

J'entraîne tous les types de joueur par contre, je préfère soit commencer avec des débutants (qui n'ont jamais joué) pour leur apprendre les bases et leur donner goût au tennis pour ensuite les amener progressivement vers ce qu'ils souhaitent (loisir ou compétition), soit des joueurs avec un niveau déjà confirmé où il faut faire des petites corrections. Ce qui est le plus compliqué pour moi c'est d'entraîner des jeunes qui ont déjà joué mais qui n'ont pas appris la bonne technique. Pour définir le type d'un joueur, je me base donc sur son niveau technique, sur l'âge, sur ses motivations, etc.

- ⇒ **Quelle est votre vision du tennis (Tennis loisir, compétitif...) ? Avez-vous une approche particulière de la compétition ?**

J'ai autant une vision du tennis loisir que du tennis en compétition. Je suis tout de même plus dans l'aspect compétitif mais c'est bien aussi de rester sur du loisir pour que les élèves soient toujours motivés et que le sport reste tout de même une activité pour se détendre. Je vais vraiment m'adapter en fonction du joueur, de sa mentalité et de ses objectifs.

- ⇒ **Pouvez-vous décrire votre implication et votre expérience en compétition en tant que coach ?**

J'ai eu l'occasion de suivre des joueurs sur des tournois en Belgique où lors d'interclubs et c'est pour moi la plus belle partie du métier de coach. On peut voir si ce qui a été

travaillé à l'entraînement se met bien en place pendant les matchs et pouvoir corriger ce qui a moins bien fonctionné par après. Je mets aussi mon implication dans le coaching sur le terrain dès que cela est autorisé.

- ⇒ **Quelles sont les principales caractéristiques qu'un coach doit posséder afin d'amener ses joueurs compétitifs ou non à s'améliorer ?**

Il faut toujours s'adapter au joueur et être à l'écoute.

- ⇒ **Comment définiriez-vous votre style de coaching (Autoritaire, participatif ou délégatif) ? Adaptez-vous votre style en fonction du joueur ?**

Je dirais que j'ai un petit peu des 3 styles mais ça dépend à nouveau du joueur. Je fais parfois du délégatif lorsque j'entraîne 2 joueurs en même temps, je propose à un des deux élèves de montrer l'exercice à ma place par exemple. Je dirais surtout que cela dépend de moment dans l'année. Il faut être plus autoritaire lorsqu'on travaille la technique et plus participatif lorsqu'on fait des exercices tactiques.

- ⇒ **Quelle est la place de la technique et de la tactique dans vos méthodes d'enseignement ?**

Je pars du principe que la technique est au service de la tactique. Donc je mets d'abord la tactique en place pour qu'elle vienne embellir la technique. J'observe d'abord comment les élèves se débrouillent tactiquement et puis j'améliore leur technique pour parvenir à réaliser l'exercice tactique. Mais il faut tout de même s'adapter au niveau et à l'ambition du joueur.

- ⇒ **Comment décririez-vous votre « touch » en tant que coach en quelques mots ?**

Je suis un coach qui prône le jeu offensif et vers l'avant tout en gardant une certaine sécurité.

Questions sur les problèmes et besoins ressentis par les coaches et directeurs d'écoles de tennis :

- ⇒ **Quels sont les principaux problèmes rencontrés au quotidien liés à votre profession ?**

En tant que co-directeur, ce sont surtout les mails inutiles des parents. Ils posent des questions alors que toutes les informations sont écrites sur notre site mais ils ne prennent

pas le temps de lire. Ils exigent aussi beaucoup de choses en dernière minute. Je pense aussi à un autre problème comme la mauvaise estimation du niveau de leurs enfants. En tant que coach, le premier problème qui me vient à l'esprit est lié à la présence des parents au bord du terrain lors des entraînements. Un autre problème est que l'entente entre les élèves n'est pas toujours bonne mais c'est assez compliqué d'avoir des élèves du même niveau, avec les mêmes disponibilités et qui s'entendent bien.

Questions visant à déterminer un processus de décision standard pour les coaches de tennis :

⇒ **Quelles sont les étapes que vous suivez quand un nouveau joueur vous contacte dans l'optique de suivre des cours de tennis ?**

On me contact soit par mail ou par téléphone, j'essaye toujours de voir l'élève et de jouer un petit peu avec lui ou de le faire venir à une journée test si c'est en début de cycle, par contre si c'est un élève qui s'inscrit en cours d'année, on l'ajoute à un groupe en fonction de son estimation de niveau et puis on voit si ça fonctionne ou pas. On demande toutes les coordonnées des élèves et puis on forme les groupes.

Questions visant à déterminer l'ensemble des inputs à prendre en compte dans la conception du système :

⇒ **Comment récoltez-vous les données signalétiques des élèves ?**

Il y a quelques années cela se faisait encore via un formulaire version papier mais désormais, ils complètent leurs données sur notre site ou alors via un mail et nous les ajoutons nous-même.

⇒ **Quelles sont les infos indispensables que les joueurs doivent vous communiquer ?**

Prénom, nom, date de naissance, adresse, adresse e-mail, numéro de téléphone, disponibilités, niveau et s'ils ont déjà joué ou pas, type de cours souhaité (particulier, groupe, etc.)

⇒ **Sur base de quels critères et attributs basez-vous l'évaluation du niveau d'un joueur dans l'optique de le placer dans un groupe ? (Niveau technique, niveau physique...)**

Je regarde d'abord sa technique globalement, s'il a le sens de la balle (3D), son aspect mental sur le terrain (s'il est vite démotivé ou pas), puis je regarde un petit peu le physique et ensuite la tactique pour les joueurs déjà plus expérimentés.

⇒ **Quand estimez-vous le niveau d'un joueur ? Au cours d'une journée test ? Au cours d'une séance ? Prenez-vous des informations concernant le niveau d'un joueur à l'extérieur (Ancien coach du joueur...) ?**

Lors de la journée test mais c'est assez difficile de réunir tout le monde et d'évaluer tout le monde sur si peu de temps. J'effectue donc un check-up complet au premier cours.

⇒ **Comment collectez-vous les disponibilités des élèves et des coachs ?**

Pour les élèves, ils doivent entrer eux-mêmes leurs disponibilités sur notre plateforme internet et pour les coachs, on communique directement avec eux.

⇒ **Comment synchronisez-vous les disponibilités des élèves avec les disponibilités des installations à votre disposition ?**

Sur notre site, nous proposons uniquement des plages horaires compatibles avec nos installations. Les heures sont déjà « pré cochées » et ils doivent décocher lorsqu'ils ne sont pas disponible.

⇒ **Quels sont vos critères afin de former des groupes ?**

L'âge des élèves afin de savoir dans quelle catégorie de balle ils vont être mais cela se fait automatiquement en fonction de la formule dans laquelle ils s'inscrivent. Ensuite, le niveau qu'ils ont (débutant, entraîné et confirmé) et par après, les disponibilités de chacun.

⇒ **Utilisez-vous d'autres critères que l'âge, le niveau et les compatibilités horaires pour former les groupes ?**

Les préférences des élèves, à combien ils veulent être et avec qui.

⇒ **Est-ce que la personnalité et les préférences d'un coach entre en compte lors de l'attribution des groupes à un coach ?**

Oui mais plutôt en dernier lieu et si on a la possibilité de le faire. C'est surtout dans les très grosses structures que ça devient possible.

⇒ **Comment déterminez-vous les exercices qui composent les entraînements ?**

Je me base sur le planning et puis je regarde en fonction des niveaux des élèves. S'il y a des petites différences de niveau, j'adapte parfois les exercices individuellement ou par binôme. Un élève fait travailler l'autre pour créer une osmose dans le groupe.

⇒ **Quelle est la part de création dans les exercices effectués à l'entraînement ? Quelles sont vos sources d'inspiration afin d'organiser une séance d'entraînement optimale ?**

Je dirais entre 10 et 15 pourcents de créativité. Mes sources d'inspiration viennent d'abord de mon expérience et ensuite des formations que j'ai suivies à l'AFT. Je m'inspire aussi parfois des autres moniteurs qui donnent cours à côté de moi aussi. On essaye de s'entraider un maximum.

Questions visant à déterminer la forme de l'interface utilisateur :

⇒ **Comment voudriez-vous encoder l'ensemble des informations concernant les joueurs ? Sur quel(s) type(s) de support(s) (tablette, smartphone...) ?**

Je préfère utiliser une tablette.

⇒ **Préfériez-vous que les élèves encodent eux-mêmes leurs infos ? Ou préféreriez-vous le faire par vous-même ? Si oui, quelles informations et pourquoi ?**

Pour les données de base, c'est plus simple que les élèves encodent tout eux-mêmes. Par contre, pour le niveau, je préfère le faire moi-même sur une tablette et directement sur le terrain.

⇒ **Quelles sont les caractéristiques que doit posséder l'interface d'un système visant à vous aider ?**

Le plus simple possible pour qu'il soit le plus efficace sur le terrain.

⇒ **Que pensez-vous d'un tableau avec des jauges à augmenter pour les différentes variables permettant d'estimer le niveau d'un joueur ?**

C'est réalisable et pas mal du tout mais il ne faut pas que ça soit trop compliqué pour ne pas perdre trop de temps.

Questions sur les outputs désirés par les coachs et directeurs d'école de tennis :

⇒ **Que désirez-vous que le système vous procure ?**

Une aide pour former les meilleurs groupes possibles.

⇒ **Pour quelles décisions voudriez-vous que le système vous fournisse une aide en priorité ?**

Pour la formation des groupes.

Questions visant à déterminer l'intérêt et l'apport éventuel du système :

⇒ **Pensez-vous qu'un système visant à aider les coachs dans leurs prises de décision peut avoir un apport positif sur votre métier ? Si oui, de quelle manière ? Si non, pourquoi ?**

Oui, ça peut vraiment apporter de l'efficacité et un gain de temps.

⇒ **Pensez-vous qu'il est envisageable d'inclure un tel système dans votre quotidien ?**

Oui clairement.